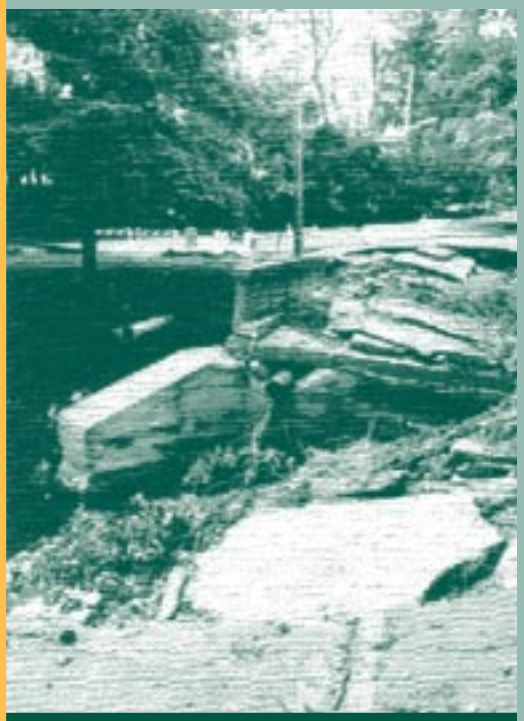
Progress Through Partnerships:

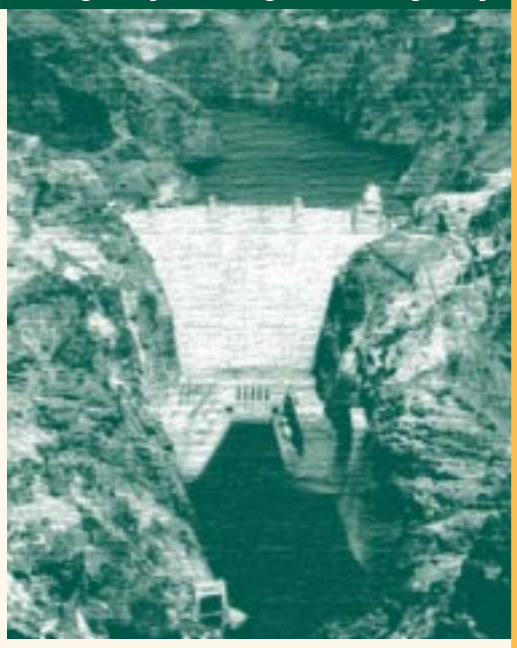
The National Dam Safety Program in Fiscal Years 1998-1999



Federal Emergency Management Agency

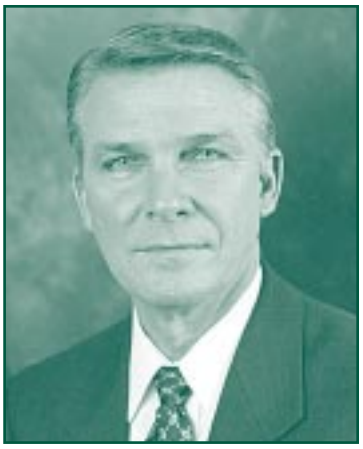
December 1999

A Report to the Congress



National Dam Safety Program

MESSAGE FROM THE DIRECTOR



I am pleased to present this biennial report on the progress and partnership of the National Dam Safety Program. Dams are a critical part of the infrastructure in our country but if not properly maintained and operated can present a risk to citizens, property, and the environment. The National Dam Safety Program is meeting the challenge of keeping our communities safe from dam failure through the efforts and cooperation of all of our partners and through the responsible investment of state and federal resources.

The benefits of our commitment to dam safety are confirmed by the performance of dams during the most recent hurricane season. The 1999 Atlantic hurricane season — a record breaker — brought 17 federally declared disasters. Hurricane Floyd alone resulted in an unprecedented 13 major disaster declarations, the most for any single hurricane or any disaster event, including the 1993 Midwest floods. In the 44 counties in North Carolina affected by flooding from Hurricane Floyd, only a few dams failed. This is success in the midst of disaster and reconfirms our dedication to dam safety and to the goals of the National Dam Safety Program.

The most important lesson to be learned from the 1999 hurricane season is that the best way to help the victims of natural disasters is to help them avoid being hit by a disaster in the first place. The creation of disaster-resistant communities is the goal of Project Impact, a national initiative designed to challenge the Nation to undertake actions that protect families, businesses, and communities by reducing the effects of all natural disasters. At the core of Project Impact is the belief that we can build disaster-resistant communities through community awareness and involvement. The National Dam Safety Program works in concert with Project Impact to ensure that all of our dams are maintained and operated safely, and that all of our communities are safer places to live.

James L. Witt

MESSAGE FROM THE ASSOCIATE DIRECTOR FOR MITIGATION

The National Dam Safety Program is dedicated to protecting the lives of our citizens and their property from the risks associated with the development, operation, and maintenance of America's dams. The control of our water resources for navigation, industry, agriculture, and recreation has provided our country with a strong legacy of dam development and operation. However, for too many of our dam owners and operators, the cost of routine maintenance has exceeded their available resources. In many cases, the general public has overlooked the consequences of neglecting this level of maintenance.

Since the passage of Public Law 104-303 in 1996, FEMA's Mitigation Directorate has been committed to strengthening and revitalizing the National Dam Safety Program. The past two years have been very successful ones. The National Dam Safety Program has new leadership and a new vision, with a strong commitment to public awareness and a dedication to partnership. FEMA's leadership initiatives in dam safety are providing the opportunity to more fully demonstrate how a modest investment in dam safety will actively mitigate the effects of dam failures and incidents. These initiatives also are increasing national exposure to FEMA programs such as Project Impact, where the dam safety community can readily contribute to the philosophy that "an enlightened citizen is a responsible citizen." Partnership is the cornerstone of FEMA's vision and it is integral to everything we do. It is key to Project Impact's goal of building disaster-resistant communities.

As we move forward over the next 2 years, we will continue to make progress in addressing all of the dam safety issues that are affecting our communities. Our intention is clear: we wish to assure the public that their lives, property, and quality of life will not be compromised because of an inadequate plan for the improvement of dam safety. This report to the Congress on the National Dam Safety Program, developed in collaboration with our federal and state partners, describes our efforts to improve dam safety in the United States.

Michael J. Armstrong

CONTENTS

EXECUTIVE SUMMARY

On October 12, 1996, President Clinton signed into law the Water Resources Development Act of 1996 (Public Law 104-303). Section 215 of Public Law 104-303 established the National Dam Safety Program and named the Director of the Federal Emergency Management Agency (FEMA) as its coordinator. The passage of the Act represented the culmination of years of collaborative effort on the part of many players in the dam safety community to statutorily create the National Dam Safety Program.

Public Law 104-303 provides for a number of initiatives in dam safety, including an assistance program to the states to improve their dam safety programs; a greatly expanded program for research and training; and the creation of a National Dam Safety Review Board to monitor the state assistance program. Public Law 104-303 states that no later than 90 days after the end of each odd-numbered fiscal year, the Director of FEMA will submit a report to the Congress that describes the status of the National Dam Safety Program, the progress achieved by the federal agencies during the two preceding fiscal years in implementing the *Guidelines,* and the progress achieved by the states participating in the Program.

Under the leadership of FEMA, a great deal has been accomplished for the National Dam Safety Program during fiscal year (FY) 1998-1999, both in terms of setting the direction for the Program in the coming years and in implementing the activities called for by Public Law 104-303.

In FY 1999, FEMA Director James Lee Witt created the new Office of National Dam Safety. The elevation of the Program has heightened its visibility within FEMA and promoted its interface with other FEMA programs and projects, including Project Impact and the National Flood Insurance Program. Strong leadership from FEMA, with a reinvigorated sense of mission, is now providing an opportunity for the Program to demonstrate how the investment in state and federal dam safety programs will actively mitigate the effects of future incidents, thus saving lives and reducing costly recovery activities.

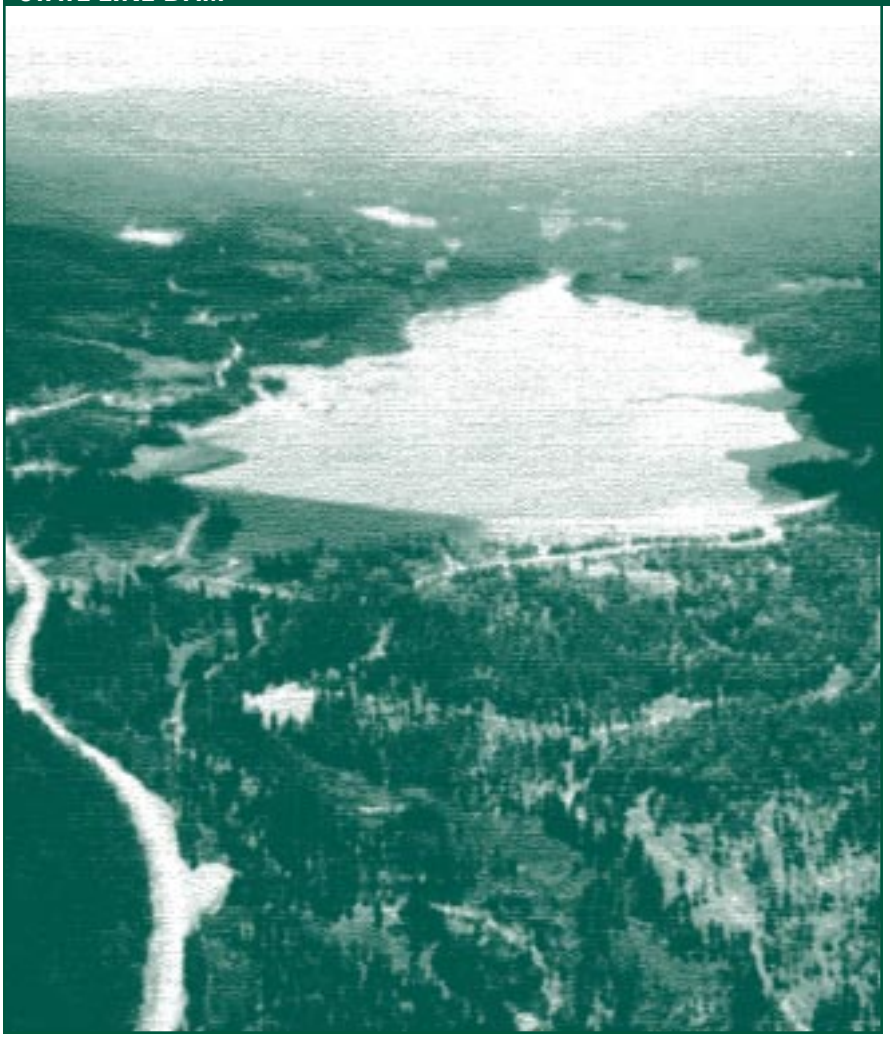
Partnership is the cornerstone of FEMA's vision and an integral part of all of its programs. Some new partnerships were initiated in FY 1998-1999 and others have been greatly strengthened. Today, the federal sector, the states, and many other stakeholders are equal partners in a national program for dam safety.

Establishment of the National Dam Safety Review Board

In FY 1998, FEMA convened the National Dam Safety Review Board. The National Dam Safety Review Board provides the Director of FEMA with advice in setting national dam safety priorities and considers the implications of national policy issues affecting dam safety. The Board also helps oversee the development and support of state dam safety programs, including the establishment of more advanced requirements and standards for state programs under the National Dam Safety Program Act.

In FY 1998-1999, the Board developed the application for state assistance funds, developed the evaluation criteria for the assessment of state performance under the National Dam Safety Program, and worked with officials from Alabama and Delaware to enable those states to participate in the Program. The National Dam Safety Review Board also has been instrumental in advising FEMA on the direction of Program policy and activities.

STATE LINE DAM



State Assistance Program

A primary purpose of the National Dam Safety Program Act is to provide financial assistance incentives to the states so that they can strengthen their dam safety programs. During this reporting period, almost all of the states participated in the Program. FEMA's goal in directing the state assistance program is 100 percent participation. For that reason, FEMA realized a major accomplishment in FY 1999 with the award of an initial grant to the State of Delaware to initiate a dam safety program.

The funds distributed to the states in FY 1998-1999 were used for a wide variety of purposes, including dam safety-related training for state personnel and training in the field for dam owners to conduct annual maintenance reviews; to purchase equipment, including state-of-the-art computer systems and software, new equipment to aid in engineering analysis, video inspection cameras to inspect conduits through dams, and laptop computers for use in the field; to increase the number of dam inspections and the submittal of emergency action plans; to improve coordination with state emergency preparedness officials; and to sponsor a joint project with FEMA's Project Impact.

Technology

A primary objective of FEMA in its leadership of the Program is to identify, develop, and enhance technology-based tools that can help educate the public and assist decision-makers. The National Performance of Dams Program and the National Inventory of Dams, both of which have received major emphasis and funding under the National Dam Safety Program, are providing invaluable data on the status of dams and dam incidents in the United States. In turn, these data are assisting Program partners in better documenting failure modes and identifying research and training needs. Through tools such as these, the quality of information at all levels in the Nation's dam safety community will continue to improve.

Research

Research provides the knowledge to develop a broad spectrum of mitigation techniques

and tools that can reduce the probability of dam failure and the impact of dam failure on lives and the environment. Under the National Dam Safety Program, the focus is on the sharing of research between the federal and state sectors and the use of archival research technologies such as the National Performance of Dams Program.

During FY 1998-1999, National Dam Safety Program participants conducted a number of activities, including the prioritization of research needs for the states, the conduct of workshops on research areas of interest such as seepage and piping, and the identification of research areas to be explored during the next reporting period, including dam safety risk analysis and risk assessment.

Training

FEMA is undertaking a number of new initiatives in the training arena, including the establishment of a core dam safety program at its training facility in Emmitsburg, Maryland. In early FY 2000, FEMA will conduct a needs assessment focus group to discuss national training needs for dam safety in the new millennium.

With National Dam Safety Program funds, the Association of State Dam Safety Officials conducted six regional technical seminars and provided travel and registration assistance to the states for attending other technical training of their choice. The regional technical seminars have covered topics such as concrete rehabilitation of dams, embankment dams, and filters and drain design.

PROGRAM PRIORITIES FOR FY 2000-2001

FEMA's priorities for the National Dam Safety Program in FY 2000-2001 include the following:

- The development and use of risk management techniques to classify and prioritize the conditions of dams
- The continued encouragement and promotion of state dam safety programs implemented through the grant assistance program
- The accurate reporting of dam incidents to better document failure modes and research and training needs
- The identification, development, and enhancement of technology-based tools to educate the public and decision-makers
- The improved development and testing of emergency action plans for all high- and significant-hazard potential dams
- The continued integration of the National Dam Safety Program with other FEMA programs, especially Project Impact and the National Flood Insurance Program
- The use of expanded outreach to share information with a wide array of stakeholders associated with dam safety
- The development of on-going technical training and public education programs that can be delivered through multiple outlets at multiple levels

Emergency action planning is a major initiative of FEMA, with a goal of 100 percent participation for all high- and significant-hazard potential dams. In early FY 2000, FEMA will host a training production, broadcast by satellite and the Internet, on emergency action planning for dams. The production, which will be broadcast on FEMA's Emergency Education Network (EENet) station, is targeted to dam owners and operators, dam safety officials, emergency managers, Project Impact communities, and the public.

HIGHLIGHTS

Overview

The last two years have been significant ones for the National Dam Safety Program and all of its partners. By the end of the last reporting period, the Federal Emergency Management Agency (FEMA) had begun a number of initiatives to implement the National Dam Safety Program Act, signed into law by President Clinton on October 12, 1996. These initiatives included the creation of an Implementation Plan to guide the establishment of the national Program; the development of procedures for the award of funds under the Act for assistance to the states, training, and research; the establishment of a National Dam Safety Review Board to advise the Director of FEMA on national policy issues affecting dam safety in this country; the revitalization of the Interagency Committee on Dam Safety (ICODS); and the enhancement of those partnerships that are integral to making sure that progress continues in dam safety. Many of these initiatives and procedures are now firmly in place.

During the last two years, FEMA undertook new initiatives to guide the direction of the Program and set a firm groundwork for achieving the goals of the National Dam Safety Program through the next century. Some of the highlights of Fiscal Year (FY) 1998 and 1999 are described below.

Elevation of the National Dam Safety Program

The primary challenge for FEMA in the start-up years of the Program has been to strengthen and broaden its leadership so that all of the goals of Public Law 104-303 can be achieved by the Year 2003. In January 1999, FEMA Director James Lee Witt responded to this challenge by elevating the National Dam Safety Program from the Hazard Studies Branch of the Mitigation Directorate directly to the Associate Director for Mitigation. The creation of the new Office of National Dam Safety serves a number of very important functions, including the heightening of the Program's visibility within FEMA and promoting the interface of the Program with other FEMA initiatives.

Strong leadership from FEMA, with a reinvigorated sense of mission, is now providing an opportunity for the Program to demonstrate how the investment in state and federal dam safety programs, including emergency action planning, public awareness, operation and maintenance, and repair and rehabilitation, will actively mitigate the effects of future incidents, thus saving lives and reducing costly recovery activities. Increased national attention and exposure to FEMA programs, such as Project Impact and the National Flood Insurance Program (NFIP), provide an opportunity for the Program to contribute to the overall philosophy that an "enlightened citizen is a responsible citizen." This will provide proven avenues of pub-

lic education and encourage individual and community responsibility for dam safety issues.

Emphasis on Partnership

When the National Dam Safety Program Act was signed into law in 1996, a primary goal was to establish a partnership between the federal government and the states. Today, the federal sector, the states, and many other stakeholders are equal partners in a national program for dam safety.

Partnership is the cornerstone of FEMA's vision and an integral part of all of its programs; it is considered key to Project Impact's goal of building disaster resistant communities across the United States. FEMA's Strategic Plan states that "The mission of FEMA mandates that FEMA's work be inseparable from that of other entities having a role in dealing with the consequences of disasters. The partnership concept, therefore, is embodied in values, strategies, and in cooperative planning with other federal, state, and local groups and representatives."

In response to the 1996 National Dam Safety Program Act, FEMA shifted its focus from oversight of federal activities to proactively coordinating the activities of its federal and state partners in providing cutting edge engineering and emergency preparedness support. To ensure that the national Program meets the goals of the Act, FEMA's focus now is on coordination of federal programs to present a consistent voice to outside groups; coordination of state programs to provide a consistent and cooperative approach to dam safety, particularly as dam safety transcends political and geographic boundaries; and raising awareness of dam safety through the application of FEMA resources and programs, such as Project Impact and the NFIP.

Some new partnerships were initiated in FY 1998-1999, such as direct relationships between the staff of the Office of National Dam Safety and all of the dam safety officials from states participating in the program. Other partnerships have been greatly strengthened during this reporting period, including those with dam safety organizations such as the United States Committee on Large Dams (USCOLD) and the American Society of Civil Engineers (ASCE). The Association of State Dam Safety Officials (ASDSO), which was founded in 1984 to serve as the official voice of the states in dam safety, is now an equal partner with FEMA in the National Dam Safety Program.

Success of the State Assistance Program

A primary purpose of the National Dam Safety Program Act is to provide financial assistance incentives to the states so that they can strengthen their dam safety programs. During this reporting period, almost all of the states participated in the Program. In FY 1998, FEMA distributed $1 million to 45 states and Puerto Rico for state dam safety programs (Alabama, Delaware, Iowa, Rhode Island, and South Dakota did not participate). In FY 1999, $2 million was awarded under the Program to 46 states and Puerto Rico (Alabama, Iowa, Indiana, and Rhode Island did not participate). For FY 2000, $4 million will be made available for state assistance.

FEMA's goal in directing the state assistance program is 100 percent participation. For that reason, FEMA realized a major accomplishment in FY 1999 with the award of an initial grant to the State of Delaware to initiate a dam safety program. The state will use the funds to establish legislation and regulations, de-

Hurricane Floyd's Toll
Left: A flood swollen river in Westchester County destroyed this 75-year-old bridge. Right: A Search and Rescue Team brings in stranded dogs from Princeville, North Carolina.

Source: FEMA News Photos

velop a budget, and staff its program. In FY 2000, FEMA will encourage the State of Alabama to establish an official dam safety program. Those states with weak programs in dam safety will be encouraged to strengthen them.

A Renewed Focus on Emergency Action Planning and Training

It is not surprising that the public and public officials can become complacent over the lack of Emergency Action Plans (EAP's) for dams when only a few recent dam failures have resulted in catastrophic consequences. A lesson from the past, however, shows how important emergency action planning can be. According to testimony after the Johnstown flood just over 100 years ago, the supposed threat from the South Fork Dam had become a "standing joke." Many people have read of the devastation that resulted from that dam failure: over 2,200 lives lost and thousands left homeless.

The *Federal Guidelines for Dam Safety* state that every federally owned, operated, and regulated high- and significant-hazard potential dam in the United States should have an EAP, a "formal document that identifies potential emergency conditions at a dam and specifies preplanned actions to be followed to minimize property damage and loss of life." In FY 1999, FEMA, through ICODS, published the Federal Guidelines for Dam Safety: Emergency Action Planning for Dam Owners. All organizations and individuals who own or are responsible for the operation and maintenance of dams are encouraged to use the guidelines to develop, update, and revise their EAP's.

Much still remains to be accomplished in this area. According to the 1998-1999 Update to the National Inventory of Dams (NID), approximately 60 percent of the high- or significant-hazard potential dams now have an EAP. Although this percentage is improving over time, nothing less than 100 percent participation is FEMA's goal in this area. To achieve that goal, FEMA is working closely with the Federal Energy Regulatory Commission (FERC), whose national training program in emergency action planning is considered without parallel. In early FY 2000, staff from FEMA, FERC, ASDSO, and the National Weather Service will participate in a nationally broadcast training program on dam safety and EAP's. The 90-minute program, which will be broadcast via satellite and the Internet, will provide dam owners and operators, dam safety officials, emergency managers, and Project Impact communities with information on the benefits and costs of an EAP, and on the resources available for EAP development. With ASDSO, FEMA is continuing to sponsor training courses for the small dam owner and state regulators on the development and exercise of an EAP.

Another important initiative during this reporting period is the interface of the Program with Project Impact to identify all high- and significant-hazard potential dams on Geographic In-

Statement of John Lovett, a Survivor of the Johnstown Flood

It commenced to rain here on Thursday night at 9 o'clock, May 30th, 1889, and it rained very hard up till Friday noon, May 31st, before it stopped: it rained very hard on Thursday night; it was the heaviest rain I ever heard; I could not see it, but I could hear it come down. This was the heaviest flood I ever saw. All the streams that empty into the reservoir were overflowed; large trees and logs of all kinds went into the reservoir; it took logs away from the Island that had been here for forty years; it also took trees out at the root. I can tell how much rain fell. I put a bucket out during the evening, and when I used it again, it had six inches of water in; there is a dam here called Sydney dam that had stood here for about fifty years. It stood all other floods, but this one carried it away.

formation System hazard maps in the 120 Project Impact communities. Information on whether the high- and significant-hazard potential dams have EAP's has been made available to community and state officials. This is value-added for local communities as they are being provided with the tools to take action and develop an EAP.

The recent dam failures in North Carolina from Hurricane Floyd confirm the value of early warning and the benefits of mitigation. The 36 dam failures occurred in 44 of North Carolina's 100 counties; in the 44 counties affected by Hurricane Floyd, there are over 1,400 dams. The dams that failed were primarily smaller, earthen low-hazard potential dams with limited spillway capacity. The EAP's for the dams functioned well—there were no reported injuries from the failures, and no additional damage over that caused by the floods.

Activities in Information Technology and Research

According to Alvin Toffler, *Third Wave*, we are now in the wave of information. Given the rapid pace of technology, those in a leadership role must recognize and make the best use of tools to accomplish their objectives. A primary objective of FEMA in its leadership of the Program is to identify, develop, and enhance technology-based tools that can help educate the public and assist decision-makers.

The National Performance of Dams Program (NPDP) and the NID, both of which have received major emphasis and funding under the National Dam Safety Program, are providing invaluable data on the status of dams and dam incidents in the United States. In turn, these data are assisting Program partners in better documenting failure modes and identifying research and training needs. Through tools such as these, the quality of information at all levels in the Nation's dam safety community will continue to improve. The development and use of risk management techniques to classify and prioritize the conditions of dams also is a program priority.

Another important focus for the future will be on the global exchange of information in dam safety. The technology and expertise that is assisting American policy makers to make smarter decisions concerning dam safety will be used increasingly on an international scale. Shortly after the Magnitude 7.3 Chi Chi earthquake in Taiwan, the United States Army Corps of Engineers sent a field reconnaissance team to evaluate the performance of earth and concrete dams during the earthquake, and to document ground failure mechanisms such as liquefaction and landslides that could affect dams. (Information on the field visit to Taiwan is posted on the Web at **www.liquefaction.com/taiwan.**)

Chi Chi Earthquake, Taiwan
On a field reconnaissance visit, the U.S. Army Corps of Engineers investigated the failure of the Shin-Kang Dam.

Source: U.S. Army Corps of Engineers, Dr. R.S. Olsen

PARTNERS IN NATIONAL DAM SAFETY

The Public

The public receives many benefits from dams, including water to drink and water for irrigation and navigation; hydroelectric power; and the creation of lakes for fishing and recreation. Most importantly, dams save lives by preventing or reducing floods.

Consider some examples of the benefits of dams posted on the web site of the United States Committee on Large Dams (USCOLD) at www.uscold.org/~uscold.

Reducing Flood Damages. During the last 12 years, California's Oroville Dam has saved more than $1.3 billion in flood damages. For the 30 years before the construction of Oroville Dam, the Feather and Sacramento Rivers experienced more than $400 million in actual flood damages.

Reducing Air Pollution. One of the major benefits of dams is the production of hydroelectric energy. The efficiency of a modern hydropower plant exceeds 90 percent, which is more than twice the efficiency of a thermal plant. If all the energy produced by hydropower were instead produced by coal, pollutants from coal would increase by 16 percent.

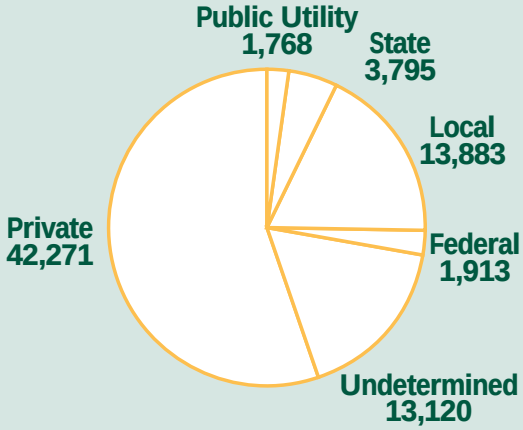
Providing Habitats for Wildlife. Dams can provide habitats for many species of wildlife. The Kingsley Dam in Nebraska provides a habitat for over 280 species of birds. Huge flocks of waterfowl and cranes live in the 6,200 acre wildlife management area during migration. Hundreds of bald eagles congregate during the winter to catch fish below the dam's hydro plant. On a single day in 1984, 386 eagles were counted.

If the public is unaware at times of the many benefits of dams, the public also can be unaware of the risk dams present, particularly if they are not properly designed, constructed, operated, inspected, and maintained. The involvement of the public through community-based projects such as Project Impact can heighten public awareness of dam safety and motivate the public to become actively involved in achieving a safer community. A primary objective of FEMA is to strengthen these partnerships, with the goal of making the public a full partner in dam safety.

TABLE 1: PURPOSES OF DAMS

PURPOSE	NO. OF DAMS	PERCENT
Debris Control	389	0.5%
Fire & Farm Ponds	10,559	13.8%
Fish & Wildlife Ponds	1,013	1.3%
Flood Control	12,002	15.6%
Hydroelectric	2,296	3.0%
Irrigation	7,275	9.5%
Navigation	250	0.3%
Recreation	25,976	33.8%
Tailings & Other	7,192	9.4%
Water Supply	7,252	9.4%
Undetermined	2,546	3.3%
TOTAL	**76,750**	

FIGURE 1: DAM OWNERS BY TYPE



TOTAL: 76,750

Source: 1997/1998 National Inventory of Dams

The Federal Emergency Management Agency

Dam safety is not solely a state or local issue. Dam safety can affect persons and property across local, state, and even national borders. An incident in one area can affect commerce, navigation, and power generation and distribution, or it can cause severe damage in another area. Therefore, there is a reasonable federal role to coordinate federal, state, and local efforts to provide dam safety to citizens.

FEMA is in a unique position to lead the National Dam Safety Program as it neither owns nor regulates dams and therefore can serve as an independent and honest broker for dam safety issues. A unified direction in dam safety across federal agencies and states ensures economies of scale and leads to other efficiencies. This also results in states and dam owners receiving the same "look and feel" from federal programs, and citizens receiving equal levels of safety from state programs.

Under FEMA's direction, experts, federal agencies, and others are developing and providing programs that are focused, coordinated, and data driven. The National Dam Safety Program is working with the states, individually and through the Association of State Dam Safety Officials (ASDSO), the American Society of Civil Engineers (ASCE), the National Performance of Dams Program (NPDP), federal agencies, and other stakeholders in dam safety to encourage individual and community responsibility for dam safety.

Two federal organizations that have an important role in guiding the direction of the National Dam Safety Program are the National Dam Safety Review Board and the Interagency Committee on Dam Safety (ICODS), both of which are chaired by FEMA.

ICODS AGENCIES

- Department of Agriculture
- Department of Defense
- Department of Energy
- Department of Interior
- Department of Labor
- Federal Emergency Management Agency
- Federal Energy Regulatory Commission
- International Boundary and Water Commission (U.S. Section)
- Nuclear Regulatory Commission
- Tennessee Valley Authority

National Dam Safety Review Board

Authorized under Public Law 104-303, the National Dam Safety Review Board provides the Director of FEMA with advice in setting national dam safety priorities and considers the implications of national policy issues affecting dam safety. The National Dam Safety Review Board also helps oversee the development and support of state dam safety programs, including the establishment of more advanced requirements and standards for state programs under the National Dam Safety Program Act.

The National Dam Safety Review Board was very active in FY 1998-1999. In addition to developing the application for state assistance funds, the Board reviewed and approved state applications for FY 1998 funds; developed the evaluation criteria for the assessment of state performance under the National Dam Safety Program; and worked with officials from Alabama and Delaware to enable those states to participate in the Program. The Review Board also has been instrumental in advising FEMA on the direction of Program policy and activities.

The membership of the National Dam Safety Review Board includes a representative from FEMA; representatives from four federal agencies that serve on ICODS; five members selected by the Director of FEMA from among dam safety officials of the states; and one member selected by the Director of FEMA to represent USCOLD.

Interagency Committee on Dam Safety

Since its formation in 1980, ICODS has encouraged federal and state agencies to establish and maintain programs, policies, and guidelines that enhance dam safety for the protection of

human life and property. This is achieved through coordination and information exchange among federal agencies and state dam safety officials with common problems and responsibilities for dam safety, *e.g.*, planning, design, construction, operation, emergency actions, inspections, maintenance, regulation or licensing, technical or financial assistance, research, data collection, and ultimate disposition. ICODS provides the permanent forum for the coordination of federal activities.

ICODS, which was formally established by Public Law 104-303 in 1996, is composed of representatives from all the federal agencies that build, own, operate, or regulate dams.

By the start of FY 1998, FEMA had reorganized all of the ICODS subcommittees to better meet the requirements of Public Law 104-303. Six subcommittees serve under ICODS and focus on activities essential to carrying out the goals of the National Dam Safety Program. During this reporting period, the Training Subcommittee and the Research Subcommittee played important roles in the establishment of funded programs for the states in their respective areas. Now that these programs are in place, there will be a shift in focus to federal activities for all of the ICODS subcommittees.

Below is a brief description of the ICODS subcommittees. The activities of the ICODS subcommittees during this reporting period are described in detail in the next section.

Operations Subcommittee

The Operations Subcommittee provides ICODS with recommendations for program activities and reviews and evaluates current activities undertaken on behalf of ICODS member agencies.

Research Subcommittee

The Research Subcommittee provides the forum for representing the dam safety research needs of the ICODS member agencies and states; prioritizes research needs; and advises ICODS of those needs and priorities.

Training Subcommittee

The mission of the Training Subcommittee is to establish, develop, and maintain a training program for federal and state dam safety agency personnel sufficient to meet (1) training requirements for state dam safety agencies in accordance with the requirements of the Program; and (2) federal dam safety training requirements.

National Inventory of Dams Subcommittee

The National Inventory of Dams (NID) Subcommittee provides guidance and recommendations concerning the data elements, format, and publication media for the NID. This is achieved through coordination and information exchange among agencies and other organizations sharing common problems and responsibilities for any aspect of dam safety requiring an inventory of dams.

Guidelines Development Subcommittee

ICODS has developed federal guidelines in the areas of emergency action planning for dam owners, hazard potential classification systems for dams, selecting and accommodating inflow design floods for dams, and earthquake analysis and design for dams. The Guidelines Development Subcommittee is charged with the maintenance and update of these publications and the establishment of additional guidelines to help achieve Program objectives.

National Dam Safety Coordination Subcommittee

The mission of this Subcommittee is to expand the stakeholders in dam safety, coordinate and facilitate communication among groups with varied interests in dams and dam safety and, using the strengths and expertise of the federal, state, and private sector, develop guidance documents and policies related to dam safety.

Federal Agencies

Since the enactment of Public Law 92-367 in 1972, which authorized the U.S. Army Corps of Engineers (Corps of Engineers) to inventory and inspect non-federal dams, the Federal Government's position concerning the importance of correcting safety deficiencies of federal and non-federal dams has been quite clear. Presidential involvement, including President Carter's October 1979 Memorandum and Executive Order 12148, President Reagan's letter to Senator Paul Laxalt regarding water development programs, and President Clinton's designation of mitigation as the cornerstone of the federal multi-hazard emergency management system, further emphasized the need for a National Dam Safety Program to enable federal agencies to address dam safety problems expeditiously.

Below is a description of federal agency responsibilities for dam safety. Table 2: Summary Status of Dams for Federal Agencies, provides data on the number of dams owned, operated, or regulated by each agency.

The **U.S. Department of Agriculture (USDA)** is a major planner, designer, financier, constructor, owner, or regulator of more than one-third of all the dams in the NID. The purposes of USDA dams include livestock water, municipal water and wastewater, electric power, flood protection, irrigation, and

TABLE 2: SUMMARY STATUS OF DAMS FOR FEDERAL AGENCIES (FY 1998-1999)

DEPT.	DAM INVENTORY				PERIODIC INSPECTIONS				INVESTIGATIONS & STUDIES	
Agency	Total	Hazard Classification			Total	Since Last Report			'98-99	Active
		High	Sig.	Low		Formal	Inter.	Const.		
USDA (Total)	26,752	1,978	2,584	21,489	11,500	1,520	13,130	350	25	62
ARS	1			1						
USFS	1,814	406	524	884	1,400	20	1,130	250	10	22
NRCS	24,822[A]	1,572	2,060	20,604	10,100[B]	1,500[B]	12,000[B]	100[B]	15[C]	40[C]
RHS	60[D]									
RUS	55[D]									
DOD (Total)	829	476	99	254	548	236	312		13	54
USACE	569	440	66	63	511	236	275		13	54
Army	218	35	33	150	37		37			
Navy	16	1		15						
Air Force	26			26						
DOE	16	2	1	13	9		8	1		
DOI (Total)	3,355	344	110	2,901	1,055[F]	173	803	4	180	141
BIA	286	77	38	171	136	11	123[G]	2	94	47
BLM	429[H]	3		426	334	16	317	1	16	4
BOR	309[I]	237	11	61	451	88	363[J]	Ongoing[K]	68	69
USFWS	178	9	18	151	59	58		1	2	3
NPS	480[L]	18	43	419	75[F]					18
OSM	1,673			1,673						
USGS	0[M]									
FERC	2,614	735	271	1,602	5,276[N]	462	3,669	585	190	115
IBWC	7	3	1	3	220	4	216		1	
MSHA (Total)	1,386	269	96	1,021	4,633	4,633				
Coal	653	241	33	379	3,610	3,610				
M/NM	733	28	63	642	1,023	1,023				
NRC	19			19	12[O]					
TVA	54	30	15	9	1,321[P]	99	80	42	3	3

fish and wildlife habitat. There are six agencies within the USDA involved with dams.

Agricultural Research Service owns, operates, and maintains dams through its research programs in hydrology and hydraulics that utilize small dams and structures.

Farm Service Agency provides financial assistance for dams through loans, loan guarantees, and grants to farmers and ranchers to conserve land and water resources, or recover from natural disasters.

U.S. Forest Service designs, finances, constructs, owns, operates, and maintains and regulates dams in conjunction with the management of national forests and grasslands.

Natural Resources Conservation Service designs, finances, and constructs dams under its technical and financial assistance programs for individuals, groups, organizations, and governmental units for water storage, sediment detention, and flood protection. The agency does not own, operate, maintain, or regulate any dams.

Rural Housing Service finances dams through loans, loan guarantees, and grants to public entities, local organizations, and non-profit corporations for rural community facilities. The agency does not

DAM SAFETY MODS.		DAMS WITH EAP'S	
'98-99	Active	High	Sig.
43	16	952	308
1			
12	6	352	108
30[C]	10[C]	600	200
32	33	433	52
32	31	418[E]	41
	2	15	11
1		2	1
43	13	275	34
6	3	29	6
2	1	1	
12	5	236	10
1	4	9	18
22			
68	97	695	251
1		2	
3	1	30	14

A Totals include small numbers of dams with currently unknown but probably low hazard classification. NRCS does not own or operate dams.

B Estimated; inspections are conducted by many non-USDA organizations without USDA involvement.

C Estimated; investigations, studies, or modifications can be done by dam owner without USDA involvement.

D Estimated; agency involvement only as lender.

E EAP's not required for dams with no expected loss of life.

F No further breakdown for NPS.

G BIA performed 82 intermediate inspections and 41 special inspections (annual).

H BLM low hazard dams less then 25 feet or 50 acre feet were dropped from this inventory.

I BOR's 457 dams and dikes listed on the National Inventory of Dams are located at 309 individual facilities. Of the 309 facilities, 248 are considered to be high- or significant-hazard facilities. The facilities count is used for this presentation because inspections, investigations, modifications, and EAP's are counted and reported for individual facilities.

J BOR conducts annual examinations on all high- and significant-hazard potential dams which do not receive a formal or intermediate examination. During this reporting period, 66 periodic examination reports were completed, plus 225 annual examination reports and 72 special examination reports.

K BOR performs quality assurance and construction contract administration activities on an on-going basis for all dam and dam safety construction.

L NPS. Limited data. No nationwide update since 1993.

M USGS low-hazard potential dams less than 25 feet or 50 acre feet were dropped from this inventory.

N Includes 560 special inspections.

O Twelve site inspections covered all 19 structures in NRC's program.

P Periodic inspections are comprised of civil, mechanical, and electrical disciplines which are counted as separate inspections. Total included approximately 1,100 monthly inspections.

design, construct, own, or operate dams.

Rural Utilities Service finances dams through loans and loan guarantees, under its Electric Program, to cooperative associations, public bodies, and other utilities in rural areas for hydroelectric and thermal electric power plants. The agency also finances dams through loans, loan guarantees, and grants under its Water and Waste Program to rural communities.

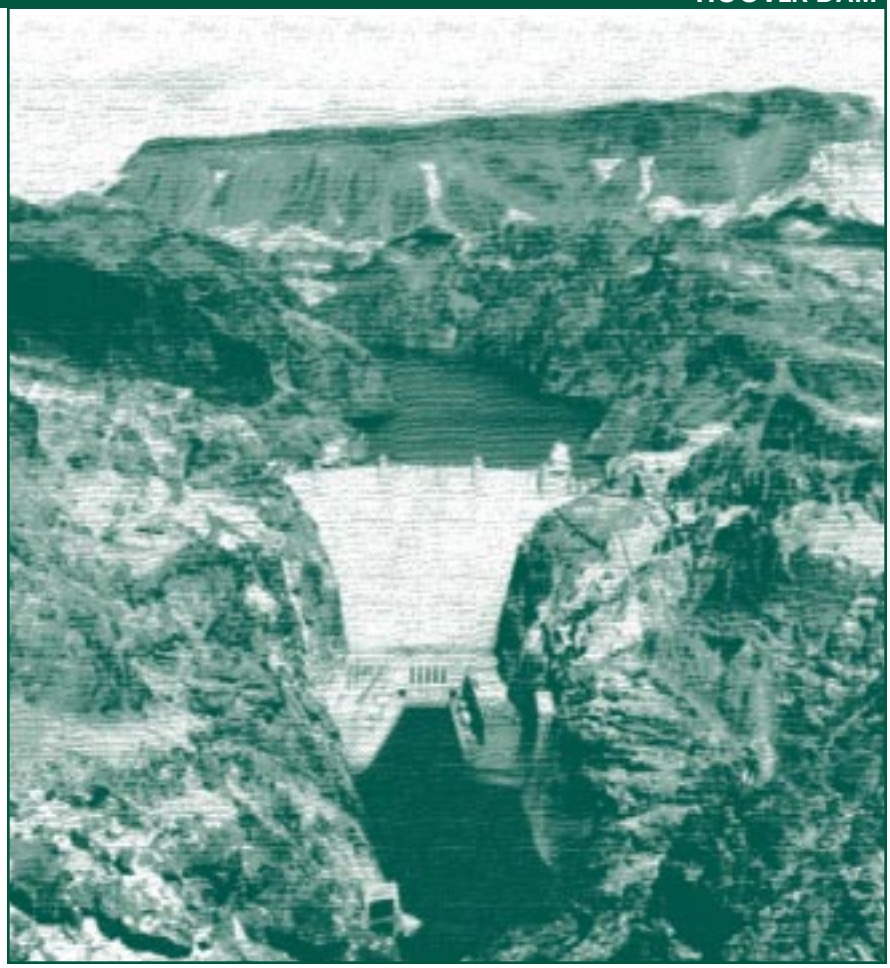
The **Department of Defense** is involved extensively with dams as a permitter, owner, manager, planner, designer, constructor, and financier. There are four Department of Defense agencies responsible for, or involved with, dams.

Department of the Air Force has dam safety responsibility for dams located on Air Force bases in the continental United States.

Department of the Army is responsible for dams that are either on Army installations or controlled by Army installations.

Department of the Navy has dam safety responsibility for dams located on Navy bases.

HOOVER DAM



U.S. Army Corps of Engineers has varying degrees of responsibility or jurisdiction for five categories of dams:

(1) dams which the Corps of Engineers planned, designed, constructed, and operates;
(2) dams which the Corps of Engineers designed and constructed, but are operated and maintained by others;
(3) those non-Corps of Engineers dams and reservoir projects subject to Section 7 of the 1944 Flood Control Act, the 1920 Federal Power Act, as amended, and other laws for which the Corps of Engineers is responsible for proscribing the regulations for the use of storage allocated to flood control and/or navigation;
(4) dams for which the Corps of Engineers issues permits under its regulatory authority; and
(5) dams that the Corps of Engineers inventoried and inspected under the National Dam Inspection Act of 1972, the Dam Safety Act of 1986, and the National Dam Safety Program Act of 1996.

The Corps of Engineers operates 237 navigation locks, 12,000 miles of commercial navigation channel, and approximately 1,200 Civil Works projects of varying types.

The **Department of Energy** owns and has jurisdiction over 16 dams, as defined in the *Guidelines.*

As the nation's principal conservation agency, the **Department of the Interior** is responsible for most of the U.S-owned public lands and natural resources**.** Through its Bureaus, the Department is responsible for the planning, design, construction, operation, maintenance, and regulation of dams meeting the definition in the *Guidelines*.

Bureau of Indian Affairs works with the American Indian Tribes to operate and maintain its dams.

Bureau of Land Management is responsible for agency-owned dams on public lands in 11 Western States, including Alaska.

Bureau of Reclamation is a federal water resource management and development bureau authorized to operate in 17 Western States.

U.S. Fish and Wildlife operates facilities associated with fish and wildlife conservation on National Wildlife Refuges, waterfowl production areas, and national fish hatcheries.

National Park Service manages stream flow structures and monitors non-National Park Service structures which are within or adjacent to park boundaries.

Office of Surface Mining regulates surface coal mining operations and the surface effects of underground coal mining operations.

U.S. Geological Survey owns and has maintenance responsibility for one low-hazard potential earthen embankment that offers no significant downstream hazard.

The **Department of Labor** responsibility for dam safety is vested in one agency. The ***Mine Safety and Health Administration*** is responsible for upholding health and safety standards for the safe design and construction of impoundments, retention dams, and tailings ponds that are a part of coal and metal/nonmetal mines.

The **Department of State** responsibility for dam safety is vested in one agency. The ***International Boundary and Water Commission***, which is composed of a U.S. Section and a Mexican Section, has jurisdiction over two large international storage dams and four small diversion dams on the Rio Grande and Colorado Rivers. The U.S. Section also is responsible for the maintenance of the American Dam and five NRCS arroyo control dams which are not fully international in nature.

The **Federal Energy Regulatory Commission** is authorized by the Federal Power Act to issue licenses to individuals, corporations, states, and municipalities to construct, operate, and maintain dams, water conduits, reservoirs, powerhouses, transmission lines, or other project works necessary for the development of non-federal hydroelectric projects on (1) navigable streams; (2) public lands of the United States; (3) at any Government dam; and (4) on streams over which the Congress has jurisdiction under the Commerce Clause of the U.S. Constitution.

The **Nuclear Regulatory Commission** has regulatory authority over only (1) uranium mill tailings dams; (2) storage water ponds at *in-situ* leach mining facilities; and (3) those dams integral to the operation of licensed facilities, or the possession and use of licensed material that pose a radiologically safety-related hazard should they fail.

The **Tennessee Valley Authority** is authorized by the Tennessee Valley Authority Act of 1933 to approve plans for the construction, operation, and maintenance of all structures affecting navigation, flood control, or public lands or reservations in the Tennessee River System. The agency has complete responsibility for the planning, design, construction, operation, and maintenance of its dams.

The States

The states have primary responsibility for protecting their populations from dam failure. Of the approximately 80,000 dams in the United States, 95 percent are owned by the states, local governmental entities, industry, or individuals.

At the state level, efforts to regulate dams to ensure public safety surfaced after the failure of the St. Francis Dam in California in 1928, the second worst event after the Johnstown failure. A few minutes before midnight on March 12, the 188-foot high St. Francis Dam failed. The newly-built dam, located about 60 miles north of Los Angeles, failed suddenly as a result of a foundation defect in an abutment. Warnings were not issued before the dam failure, and about 420 people died.

The failure of the St. Francis Dam led to the enactment of legislation in California, which became the model for laws in other states. By the mid-1970's, approximately one-half of the states had a system for protecting the public from the potential hazards of dams. Today, all but two states (Alabama and Delaware) have adopted dam safety regulatory laws, although legislative authority, budgets, and personnel dedicated to dam safety vary greatly among the states.

Since its founding in 1984, ASDSO has moved to a leadership role in dam safety and now serves as the official voice for the states. There are five regions active in the support of the Association, 48 full voting members including Puerto Rico, and over 1,800 members when Associate, Affiliate, and Student members are included. ASDSO has working relationships with a number of organizations, including Southern University, Rebuild America Coalition, the National Emergency Management Agency (NEMA), the Canadian Dam Association, ASCE, the National Watershed Coalition, and USCOLD. The web site address for ASDSO is www.damsafety.org.

The goals of ASDSO are to:

- Improve the efficiency and effectiveness of state dam safety programs
- Foster public awareness
- Provide leadership through facilitation of interorganizational, intergovernmental, and interstate cooperation
- Provide assistance to the dam safety community and provide a forum for the exchange of information
- Provide representation of dam safety interests before state legislatures and before Congress

ASDSO was very active in FY 1998-1999, both with initiatives funded under the National Dam Safety Program (described in the next section) and with its own activities undertaken on behalf of the states.

Under the ASDSO Peer Review Program, experts in dam safety conducted reviews of the programs of the States of Ohio, Pennsylvania, and Kansas, and of the federal dam safety program of the Mine Safety and Health Administration. Plans are underway to conduct peer reviews in Maryland and either Nebraska or Massachusetts. Other peer reviews conducted by ASDSO include BCHydro, Ontario Hydro, and the Department of the Interior's Bureau of Reclamation.

Changes in standards over time, coupled with the recognition that many areas of the Model State Dam Safety Program manual need a more objective approach, prompted an update to the manual. The manual, which has been used by many states as a benchmark over the past 6 years, was revised in 1997 and published in early 1998. The Model State Dam Safety Program manual will be used as a tool for the states to follow as they upgrade their programs under the National Dam Safety Program.

Since FY 1998, ASDSO has been convening semi-annual meetings of a small group of dam safety experts from the states, federal agencies, and the private sector, along with other groups with an interest in dam safety, such as USCOLD, ASCE, and NEMA. The National Dam Safety Forum, which represents all sectors of the dam safety community, was formed to embrace a wider range of stakeholders in dam safety, to facilitate stronger communication between all players in the dam safety community, and to develop a national dam safety agenda.

Conferences and technical seminars sponsored by ASDSO during FY 1998-1999 include regional conferences for all of the ASDSO regions (Western; Southeastern; Midwest; Mid-Atlantic; and New England) and the 1998 annual ASDSO conference held in Las Vegas, Nevada, where FEMA Director James Lee Witt won the National Award of Merit.

Other ASDSO activities during FY 1998-1999 include the "Dam Facts Brochure," a media kit/educational package for the layperson, and the ASDSO Scholarship Program from which the Association chooses engineering applicants from across the United States.

Other Partners in Dam Safety

There are many national and international organizations with interests in dam safety. Two organizations that have been active over the years with the National Dam Safety Program are described below.

The United States Committee on Large Dams

Established in the early 1930's, USCOLD is a nationwide professional organization that focuses on dams and water resources development. USCOLD also represents the United States as one of the 81 member countries of the International Committee on Large Dams (ICOLD). The primary objectives of USCOLD are to:

- Advance the technology of dam engineering, construction, operation, maintenance, and dam safety
- Foster socially and environmentally responsible water resources projects
- Promote public awareness of the beneficial role of dams in the sustainable development of the Nation's water resources

The 20 technical committees of USCOLD develop guidelines and technical criteria for large dams in the United States. Representatives from the USCOLD technical committees also participate on ICOLD committees for the development of international criteria and guidelines that are widely used by governments and

PARTNERS IN DAM SAFETY

- American Consulting Engineers Council
- American Planning Association
- American Red Cross
- Associated General Contractors of America, Inc.
- Association of State Floodplain Managers
- Earthquake Engineering Research Institute
- Electric Power Research Institute
- The Hazard Mitigation Institute
- Institute for Business and Home Safety
- International City/County Managers Association
- International Association of Emergency Managers
- National Association of Counties
- National Conference of State Legislatures
- National Emergency Management Association
- National Public Works Association
- National Society of Professional Engineers
- Natural Hazards Research and Applications Information Center
- Public Risk Management Association
- Water Environment Federation

organizations such as the World Bank. USCOLD conducts its activities through several technical committees that cover all aspects of dam safety, including the planning, design and construction of dams, the environment, and public awareness.

During FY 1998 and 1999, USCOLD committees developed technical guidance, a compendium of experiences in engineering and dam safety, including information on earthquakes, floods, and other natural disaster considerations, and issued technical publications on all aspects of dam safety. To inform the public about water resource development and the importance of dam safety, USCOLD, in cooperation with FEMA, ASDSO, and others, is developing a video on dams through its Committee on Public Awareness. USCOLD also is developing white papers on topics such as risk assessment/evaluation, the use and importance of the NPDP, and the economic benefits of water resources development. All of these activities are coordinated with the National Dam Safety Program.

Other USCOLD activities conducted in FY 1998 and 1999 that relate to dam safety include:

- Annual Lecture 1998: Managing the Risks of Dam Project Development, Safety and Operation
- Annual Lecture 1999: Dealing with Aging of Dams
- Workshop: The Application of Risk Assessment in Dam Safety
- Panel on dam safety with representatives from federal agencies, dam owners, and ASDSO at the 1999 ASDSO Annual Conference
- Fifth International Benchmark Workshop 1999: Numerical Analysis of Dams
- Participation in the 1998 ICOLD Symposium: Rehabilitation of Dams
- Participation in the 1999 ICOLD Symposium: Dam Foundations: Problems and Solutions
- Participation in the 1999 ICOLD Workshop: Benefits and Concerns about Dams

The American Society of Civil Engineers

Founded in 1852, the ASCE represents more than 130,000 civil engineers worldwide, and is America's oldest national engineering society. More than 6,000 civil engineers serve on over 580 national committees that produce the Society's annual convention, specialty conferences, publications, policies, building codes and standards, and other services that benefit the Society. The ASCE is the world's largest publisher of civil engineering information.

The mission of ASCE is to advance professional knowledge and improve the practice of civil engineering as:

- The lead professional organization serving civil engineers and those in related disciplines
- The focal point for development and transfer of research results and technical, policy, and managerial information
- The catalyst for effective and efficient service through cooperation with other engineering and related organizations

ASCE established the semi-autonomous Geo-Institute (G-I) in October 1996 to serve the specialized needs of related geo-professionals. A primary goal of G-I is to increase collaboration and coordination among the professionals involved in dam safety activities and to provide input to their membership on the dam safety activities of the National Dam Safety Program. The expected results of this participation include joint ICODS/ASCE guidelines for dam safety practices, improved communication with practicing engineers on issues related to dam safety and, ultimately, an improved level of practice among the professionals involved with dam safety. The expected results should translate to an increased level of safety for the Nation's dams.

NATIONAL DAM SAFETY: A PICTURE OF PROGRESS

The Foundation for a National Program

In this century, the rapid growth of the American economy and population caused a corresponding increase in the demand for water infrastructure projects. Legislation such as the Reclamation Act of 1902, the Tennessee Valley Authority Act of 1933, and the Flood Control Acts of 1936 and 1938 resulted in large numbers of government-built new dams. Many of the new dams were larger in size because of advances in construction and materials, particularly in earth-moving equipment. Dam building in the United States peaked during the 30 years following World War II, when over one-half of the Nation's total of almost 80,000 dams were built.

In the event of a dam failure, the potential energy of the water stored behind even a small dam can cause loss of life and great property damage if there are people downstream. Several dam failures in the 1970's caused the Nation to focus on inspecting and regulating these important structures.

In February 1972, a privately-owned tailings dam in Buffalo Creek, West Virginia failed, devastating a 16-mile valley with 6,000 inhabitants. As a result of the failure, 125 people were killed and 3,000 were left homeless. In 1976, Teton Dam in Idaho failed, causing $1 billion in property damage and leaving 11 dead. In May 1977, Laurel Run Dam in Pennsylvania failed, resulting in 43 lives lost. Six months later, Kelly Barnes Dam in Georgia failed, killing 39 people, most of them college students.

In response to the Buffalo Creek disaster, Congress enacted the National Dam Inspection Act (Public Law 92-367) in 1972, which authorized the Corps of Engineers to inventory and inspect all non-federal dams. The inventory was funded at that time; the inspection phase had to await the Kelly Barnes Dam failure, when President Carter directed the Corps of Engineers to inspect non-federal dams for the states. After the Teton Dam failure, President Carter issued a memorandum on April 23, 1977, directing a review of federal dam safety activities by an *ad hoc* panel of recognized experts.

In June 1979, the *ad hoc* interagency committee on dam safety issued its report, which contained the first guidelines for federal agency dam owners. In October of that same year, President Carter directed the federal agencies to implement the guidelines recommended in that report. The *Federal Guidelines for Dam Safety* (*Guidelines*) encourage strict safety standards in the practices and procedures employed by federal agencies or required of dam owners regulated by federal agencies. They provide the most complete and authoritative statement available of the desired management practices for promoting dam safety and the welfare of the public.

Despite the strengthening of dam safety programs since the 1970's, dams continue to fail, causing loss of life and millions of dollars in property damage. In July 1994, Tropical Storm Alber-

to caused over 230 dam failures in Georgia, resulting in 3 deaths (ASDSO 1998 Survey Data). Between 1960 and 1997, there have been at least 23 dam failures causing 1 or more fatalities. Some failures also caused downstream dams to fail. There were 318 deaths as a result of these failures (ASDSO 1998 Survey Data). The number of fatalities resulting from dam failures is highly influenced by the amount of warning provided to people exposed to dangerous flooding, and the number of people occupying the dam failure floodplain.

The recent dam failures in North Carolina from Hurricane Floyd confirm the value of early warning and the benefits of mitigation. The 36 dam failures occurred in 44 of North Carolina's 100 counties; in the 44 counties affected by Hurricane Floyd, there are over 1,400 dams. The dams that failed were primarily smaller, earthen low-hazard potential dams with limited spillway capacity. The Emergency Action Plans (EAP's) for the dams functioned well—-there were no reported injuries from the failures, and no additional damage over that caused by the floods.

The creation of the National Dam Safety Program with FEMA as the lead agency is now 20 years old. Most dams in the United States are privately owned, located on private property, and not directly in the visual path of most Americans. These factors contribute to the challenge of raising the issue of dam safety in the public consciousness and getting the information on dam safety to those who need it.

Statement of Elaine Johnson,
a Survivor of the Teton Dam Flood

I was a teenager when the Teton Dam broke. This picture is my bedroom afterward. It was clean before, I swear. The next door neighbors were out of town at the time. My dad broke into their house and turned the electricity off. The neighbor's house across the street just clipped the corner of our house as it went by and

ended up a mile down stream. That mud smelled really bad! We were directly down-flood from the stockyards, the rodeo grounds, the sawmill, and a fertilizer plant. A few days of June sun and the parts of the mess that used to be alive started to rot. Then the weather turned cold. The third Sunday in June, I saw snow in Rexburg. Everyone's hands were always wet trying to clean. My dad got the water pump working but the water heater was trash so you had to wash in ice cold water. Our hands were so cold the bones ached. It stayed cold for most of a week.

It was very important to get the mud washed off of and out of things before it dried. The valley's soil has a high clay content and the Dam was made of

material intended to harden and set. Once the mud dried it didn't want to go anywhere. If you wet it down, it would stink again.

The National Dam Safety Program Act

On October 12, 1996, President Clinton signed into law the Water Resources Development Act of 1996 (Public Law 104-303). Section 215 of Public Law 104-303 established a National Dam Safety Program and named the Director of FEMA as its coordinator.

National Dam Safety Program Act

Purpose

The purpose of the National Dam Safety Program, as expressed in Section 215(a) of Public Law 104-303, is to "reduce the risks to life and property from dam failure in the United States through the establishment and maintenance of an effective national dam safety program to bring together the expertise and resources of the federal and non-federal communities in achieving national dam safety hazard reduction."

Objectives

The objectives of the National Dam Safety Program are to:

1. ensure that new and existing dams are safe through the development of technologically and economically feasible programs and procedures for national dam safety hazard reduction;
2. encourage acceptable engineering policies and procedures to be used for dam site investigation, design, construction, operation and maintenance, and emergency preparedness;
3. encourage the establishment and implementation of effective dam safety programs in each state based on state standards;
4. develop and encourage public awareness projects to increase public acceptance and support of state dam safety programs;
5. develop technical assistance materials for federal and non-federal dam safety programs; and
6. develop mechanisms with which to provide federal technical assistance for dam safety to the non-federal sector.

Initiatives

Public Law 104-303 directs FEMA to carry out a number of initiatives. These initiatives are summarized below:

1. Establish the Interagency Committee on Dam Safety;
2. Exercise leadership by chairing the Interagency Committee on Dam Safety to coordinate federal efforts in cooperation with state dam safety officials;
3. Transfer knowledge and technical information among the federal and non-federal elements;
4. Provide for the education of the public, including state and local officials, in the hazards of dam failure and related matters;
5. Provide funding to the states to establish and maintain dam safety programs through a grant assistance program;
6. Provide training for state dam safety staff and inspectors;
7. Establish a National Dam Safety Review Board to monitor state implementation of Section 215 and advise FEMA on implementation of the Program;
8. Establish a program of technical and archival research to develop improved techniques, historical experience, and equipment for rapid and effective dam construction, rehabilitation, and inspection, and devices for the continued monitoring of the safety of dams. FEMA also will provide for state participation in research and periodically advise all states and Congress on the results of the research;
9. Report to Congress on the availability of dam insurance and make recommendations on greater availability; and
10. Report to Congress (biennially) on the status of the Program, the progress achieved by federal agencies during the two preceding fiscal years in implementing the *Federal Guidelines for Dam Safety*, and the progress achieved in dam safety by states participating in the Program. The Report to Congress also will include recommendations for legislative or other action that the Director of FEMA considers necessary to achieve Program goals and objectives.

Dam Safety Today

National Activities in FY 1998-1999

Research

Research provides the knowledge to develop a broad spectrum of mitigation techniques and tools that can reduce the probability of dam failure and the impact of dam failure on lives and the environment. Under the National Dam Safety Program, the focus is on the sharing of research between the federal and state sectors and the use of archival research technologies such as the National Performance of Dams Program (NPDP).

Needs Assessment

The most important step in the establishment of a good research program is to conduct a needs assessment. In April 1999, the Research Subcommittee, at the request of FEMA, co-hosted a Research Needs Workshop in Washington, D.C. with the Association of State Dam Safety Officials (ASDSO). The Workshop participants prioritized research needs for the states. The research categories include outlets/gates, spillways, hydrology model analysis, dam failure analysis, reclamation, funding, and overtopping. A report on the Workshop results is available through FEMA.

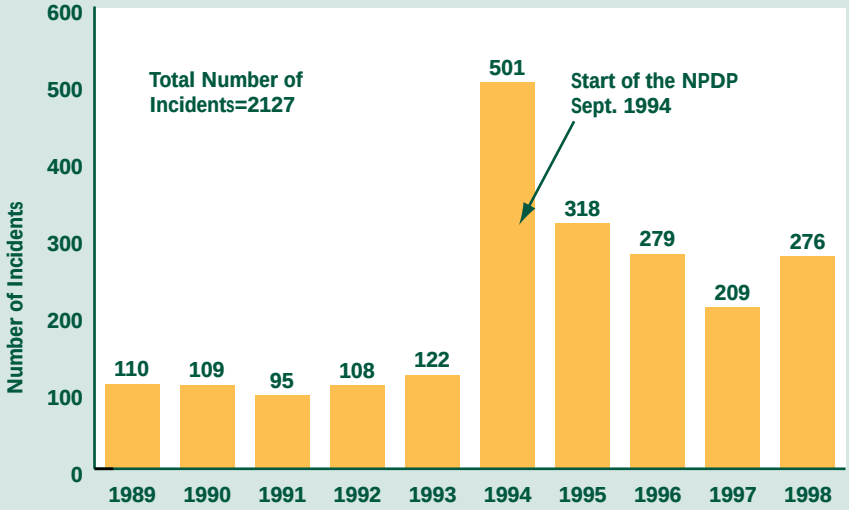
National Performance of Dams Program

The NPDP, headquartered at Stanford University, works with FEMA and leading dam safety organizations to retrieve, archive, and disseminate information on the performance of dams that will support efforts to improve dam safety, dam design and rehabilitation, and support the implementation of effective public policy. The NPDP operates a database and library on the performance of dams to meet the needs of dam safety professionals. The NPDP home page is http://npdp.stanford.edu/.

One of the early steps in the creation of the NPDP was the development of a standard for reporting dam incidents. With the support of FEMA, the Guidelines for Reporting the Performance of Dams was prepared. The Guidelines define the events that are considered dam incidents, how an incident should be reported, and where to send the information. The Guidelines define a reporting process to gather information on events that provide insight into the structural and operational integrity of dams. This broad definition of dam incidents is intended to gather data on dam failures and, more importantly, on events that are precursors to failure.

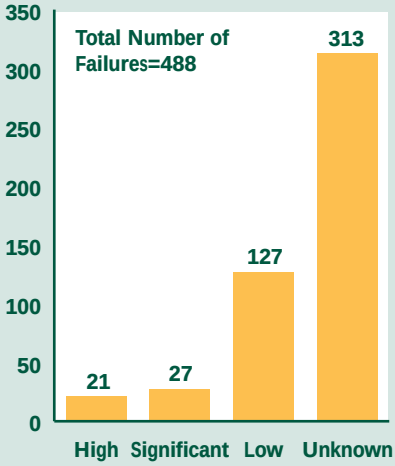
With a grant from the National Dam Safety Program, the NPDP is developing a Web-based digital library system that will make the program database and archives readily available.

FIGURE 2:
TEN-YEAR SURVEY OF DAM INCIDENTS: 1989-1998



Source: National Performance of Dams Program

FIGURE 3:
HAZARD CLASS DISTRIBUTION FOR DAM FAILURES



The digital library will meet the information needs of dam safety professionals, ranging from the engineer involved in regulation or design review to the policy maker required to balance the risks of dam operation with prudent public policy.

ASDSO is working with the NPDP and encouraging states to participate in the program by submitting dam performance data. An incentive grant program has been established; to date, over one-half of the states have signed Memoranda of Agreements to participate. As part of this program, promotional meetings have been held in every ASDSO region to answer questions, explain the program, and offer tips on how to set up an in-house policy and procedure for submitting data to the NPDP.

As part of a grant from FEMA under the National Dam Safety Program, the NPDP conducted a survey of dam incidents on file in program archives for the 10-year period from 1989-1998. In this period, a total of 2,127 events were identified. Figure 2 shows the number of incidents that are known to have occurred annually. The chart illustrates the incompleteness of available data and the role of the NPDP in realizing how many dam incidents may occur each year. (The dramatic increase in the number of dam incidents starting in 1994 is attributed to the Georgia floods that produced over 200 dam failures alone, and the formal start of the NPDP in the fall of 1994.) Of the 2,127 dam incidents, 488 involved dam failure in which there was a breach of the dam and uncontrolled release of the reservoir. For the dams that failed, Figure 3 shows the hazard classification distribution. More than 50 failures occurred at high- and significant-hazard potential dams.

For the 2-year period from 1998-1999, a total of 513 incidents occurred. For the same period, a total of 43 dam failures occurred (data is reported through September 23, 1999, and does not include failures from Hurricane Floyd). Figures 4 and 5 provide a year/monthly breakdown of dam incidents and failures that occurred in 1998-1999.

Data from 1998 indicate that 17 states and 3 federal agencies submitted at least 1 Dam Incident Notification to the NPDP. A review of the reporting practices for 1997 and 1998 indicate that 5-10 states are submitting dam incident in-

FIGURE 4: 1998-1999 DAM INCIDENTS

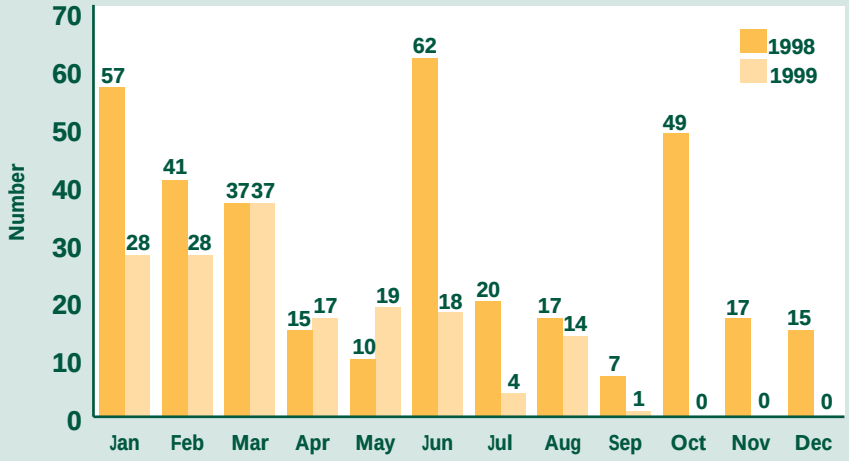
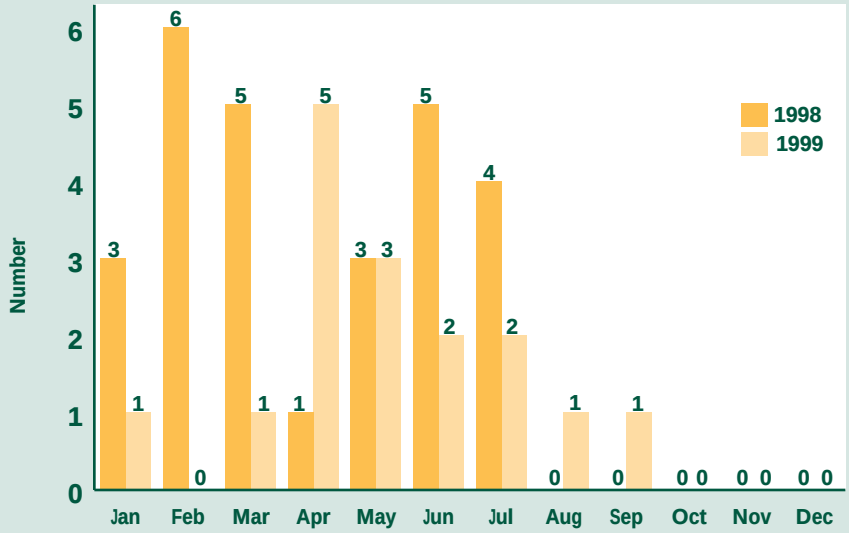


FIGURE 5: 1998-1999 DAM FAILURES



Source: National Performance of Dams Program

formation on a consistent basis. Based on current reporting practices, it is not known how many dam incidents and failures occur each year. With 10-20 percent of the states reporting on a consistent basis, it is easy to speculate that the actual number of events that may occur is considerably greater.

STATE TRAINING FY 1998-1999

- ASDSO 1998 Annual Conference
- ASDSO Rehabilitation of Concrete Growth
- ASDSO HEC-HMS and HEC-1
- ASDSO 1999 Western Reg. Conference
- ICODS Piping and Seepage Seminar
- ASDSO Embankment Dams
- ASDSO Mid-Atlantic Conference
- BOR SEED Seminar
- ASDSO Southeast Reg. Conference
- FEMA HEC-HMS
- ASDSO 1999 New England Reg. Seminar
- Premier Eng./UofKS HEC-RAS Ver. 2.1
- GA Tech Hydro Eng. for Dam Design
- ASCE Wetland Permitting Regulations
- GA Tech Embankment Dam Design
- ASDSO Midwest Reg. Tech Seminar
- Univ. of WI: Repair and Removal
- Ohio River Valley Soils Seminar
- ASCE Ground Modification
- OWRB Dam Safety Conference
- Univ. of FL: Embankment Dams
- Col. State Univ.: Tailings & Mine Waste
- ASCE Slope Stability and Stabilization
- FERC EAP Training
- SITES Training
- ASCE Intro. To HEC-RAS
- VA Tech.: Slope Stability Seminar
- 5CCC Advanced Visual Basic Program.
- Univ. of WI: Repair of Concrete
- Assn. of Eng. Geologists: Found. Rehab.
- Nat. Water Man. Center UNET Training
- FERC EAP Exercise Course
- PCA Roller Compacted Concrete Dams
- Utah State Univ.: Geotech Eng. Symposium
- MS Office Seminar
- ASCE Lifeline EQ Engineering
- BCHydro/BOR Int. Diag. Embank. Dams
- ASCE G-I Conference and Short Courses
- American Concrete Inst. Slabs on Concrete
- Univ. of WI: HEC-RAS

Seepage and Piping

At the start of FY 1999, the Research Subcommittee identified a problem common to the dam industry, and one which poses great risk to dams, downstream populations, and to the environment. In December 1998, the Bureau of Reclamation, with Program funding, hosted a workshop on the subject of piping and seepage associated with conduits through embankment dams. The Workshop focused on R&D needs and disseminating existing technical information on this very important dam safety issue. ICODS Technical Seminar #6, held in February 1999, presented the results of the Workshop to over 200 stakeholders in dam safety.

Workshops

Research topics to be explored through workshops with National Dam Safety Program funds include gate structures in dams; seepage through dams; issues, remedies, and research needs on animal and vegetation invasion of dams; and dam safety risk analysis and risk assessment. The workshops will be conducted in FY 2000.

Training

Training has been a primary focus of FEMA over the past decade and is critical to the sharing of expertise between the federal and state sectors. FEMA is undertaking a number of new initiatives in this area, including the establishment of a core dam safety program at its training facility in Emmitsburg, Maryland, the Emergency Management Institute (EMI). The facility will be

used for resident, in-field, and EENet training, and seminars and workshops. In early FY 2000, FEMA will conduct a needs assessment focus group to discuss national training needs for dam safety in the new millennium. Training activities conducted in FY 1998-1999 are described below.

Regional Technical Seminars and State Training Assistance

With National Dam Safety Program funds, ASDSO conducted six regional technical seminars and provided travel and registration assistance to the states for attending other technical training of their choice. Over 200 state personnel received training with FY 1998 grant funds.

Training Aids for Dam Safety

One of FEMA's most successful training initiatives is the Training Aids for Dam Safety (TADS) program, which uses an array of modern training materials. The TADS program consists of three parts: (1) the inspection component, in which state regulators are taught how to conduct a dam safety inspection; (2) the awareness component, which emphasizes dam safety mitigation; and (3) the analysis component, in which state regulators are taught how to analyze dam safety data. Two TADS modules are in the process of being updated: the inspection embankment dams module and the module on evaluation of seepage conditions.

Emergency Action Planning

Emergency action planning is a major initiative of FEMA, with a goal of 100 percent participation for all high- and significant-hazard potential dams. In early FY 2000, FEMA will host a training production, broadcast by satellite and the Internet, on emergency action planning for dams. The production, which will be broadcast on FEMA's EENet station, is targeted to dam owners and operators, dam safety officials, emergency managers, Project Impact communities, and the public. Information covered during the broadcast will include the cost of an Emergency Action Plan (EAP) and the resources available for development and testing. Videotapes of the broadcast will be made available.

In 1993, FEMA, in partnership with the Federal Energy Regulatory Commission (FERC), developed training on the development and testing of an EAP. The training course, which was pilot tested in 1994 and 1995, is designed for all dam owners and emergency preparedness personnel. Since the pilot course, FEMA has revised the materials to focus on training the small dam owner and operator. Training sessions on how to develop an EAP are being conducted at the regional level through ASDSO. In FY 1998, FEMA also pilot tested a training course on the exercise of an EAP. This course will be ready for delivery in FY 2000.

ICODS Technical Seminar Series

A major initiative of ICODS is its Technical Seminar Series. As we move into the next century, the number of engineers with expertise in the planning, design, and construction of dams is decreasing; there will be few new engineers with expertise in the actual design and construction of dams to participate effectively on technical review boards. The ICODS Technical Seminar Series is designed to enhance the level of expertise and the information available to all of the engineers in the Nation's dam safety community. To date, six Technical Seminars have been sponsored by ICODS. The topics of Technical Seminars held during this reporting period were mitigation strategies for dam safety and seepage and piping. ICODS Technical Seminar #7, Spillway Gates: A Critical Aspect of Dam Safety, will be held at EMI on February 23-25, 2000.

Videotape Expert Series

For the past 4 years, a major effort of ICODS has been to record videotape presentations by world-renowned civil engineering experts. In March 1999, ICODS completed the fourth videotape in the series. The philosophy of the videotape series is to introduce future generations of engineers and those currently in the profession to the person behind the literature. The expert videotapes have become best sellers, with wide distribution to government (federal, state, and local), the private sector, and academia. The videotapes are available through ASDSO.

ICODS Technical Guidelines

In FY 1999, the Guidelines Development Subcommittee completed the update of the following Technical Guidelines.

- Federal Guidelines for Dam Safety: Emergency Action Planning for Dam Owners
- Federal Guidelines for Dam Safety: Hazard Potential Classification System for Dams
- Federal Guidelines for Dam Safety: Selecting and Accommodating Inflow Design Floods for Dams

These publications, based on the most current knowledge and experience available, provide authoritative statements on the state of the art for three important areas in dam safety. In early FY 2000, the Guidelines Development Subcommittee will complete the update of the guideline on earthquake analyses and design of dams and a glossary of terms.

National Inventory of Dams

The NID is a computer database used to track information on the Nation's water control infrastructure. Information from the NID is used in the development of water resource management, land use management, flood plain management, risk management, and emergency action planning. The NID update process involves a partnership of 68 states, territories, and federal agencies, in coordination with the Corps of Engineers, FEMA, and ASDSO. The revised update process assists and strengthens the states' ability to maintain current information on the water control infrastructure and to transmit that information to the NID. Access to the NID is available at www.tec.army.mil.

The NID was first established in 1975 as a source of information for the management of risk related to dams. Each dam in the NID is assigned a downstream hazard potential classification (by the appropriate regulating authority), based on the potential loss of life and damage to property should the dam fail. With the changes in demographics and post-construction land development in downstream areas, hazard potential classifications need to be updated continually to reflect the dam's current status.

During this reporting period, significant changes have been made to the NID data, including the addition of new dam records and the removal of breached dams and duplicate dam records. Several new fields have been added to assess dam characteristics, and to more effectively and appropriately allocate federal resources for dam safety. A Geographic Information System viewer also is provided to display and analyze data.

As the update process continues, the quality of information at all levels in the Nation's dam safety community continues to improve. State inspections and data sharing among state and federal agencies will verify or amend existing data, and identify or complete missing information. The key advantages of this methodology are that it leverages the economic advantages of a partnership effort, fosters cooperation among state and federal agencies, and strengthens risk management and decision-making at the state and national level.

Data from the NID can be readily accessed to provide decision-makers with statistical information such as the following:

- State dam safety programs are responsible for the regulation of 60 percent of the dams in the country.
- National development of water control infrastructure is shifting from a construction phase to a maintenance and rehabilitation phase.
- Thirty percent of the dams in the NID have a high- or significant-hazard potential. Downstream hazard potential classifications of high, significant, or low are assigned to each dam in the NID to identify the risk dams can pose due to failure or negligent operation.
- About 60 percent of the high- and significant-hazard potential dams have an EAP, as required by the *Guidelines*. These guidelines state that an EAP, commensurate with dam size and location, must be formulated for each dam. No EAP's have been prepared for 39 percent of the dams with high-hazard potential, and 44 percent of dams with significant-hazard potential.

Federal Agency Accomplishments

The October 4, 1979 Presidential memorandum that directed federal agencies responsible for dams to adopt and implement the *Guidelines* also directed the heads of these agencies to submit progress reports to the Director of FEMA. Since that initial report in 1980, the Director of FEMA has solicited follow-up progress reports from the agencies at 2-year intervals.

Highlights for FY 1998-1999

The majority of the federal agencies continued to maintain excellent progress in a number of the implementation areas of the *Guidelines*, particularly in research and development, training, emergency action planning, and independent reviews.

In research and development, some agencies have become national experts in their speciality fields, such as the Natural Resources and Conservation Service (NRCS) and the Agricultural Research Service (ARS) in model erosion processes on earth spillways; the Tennessee Valley Authority (TVA) in concrete growth caused by Alkali Aggregate Reaction; and the Corps of Engineers, and the Bureau of Reclamation (BOR) in risk analysis. Training programs, where funding permits, continue to be a strong aspect of the agency programs. Almost all of the agencies participate in the ICODS-sponsored technical seminars and report the use of the TADS modules. On-the-job training also is an integral part of many agencies' training programs.

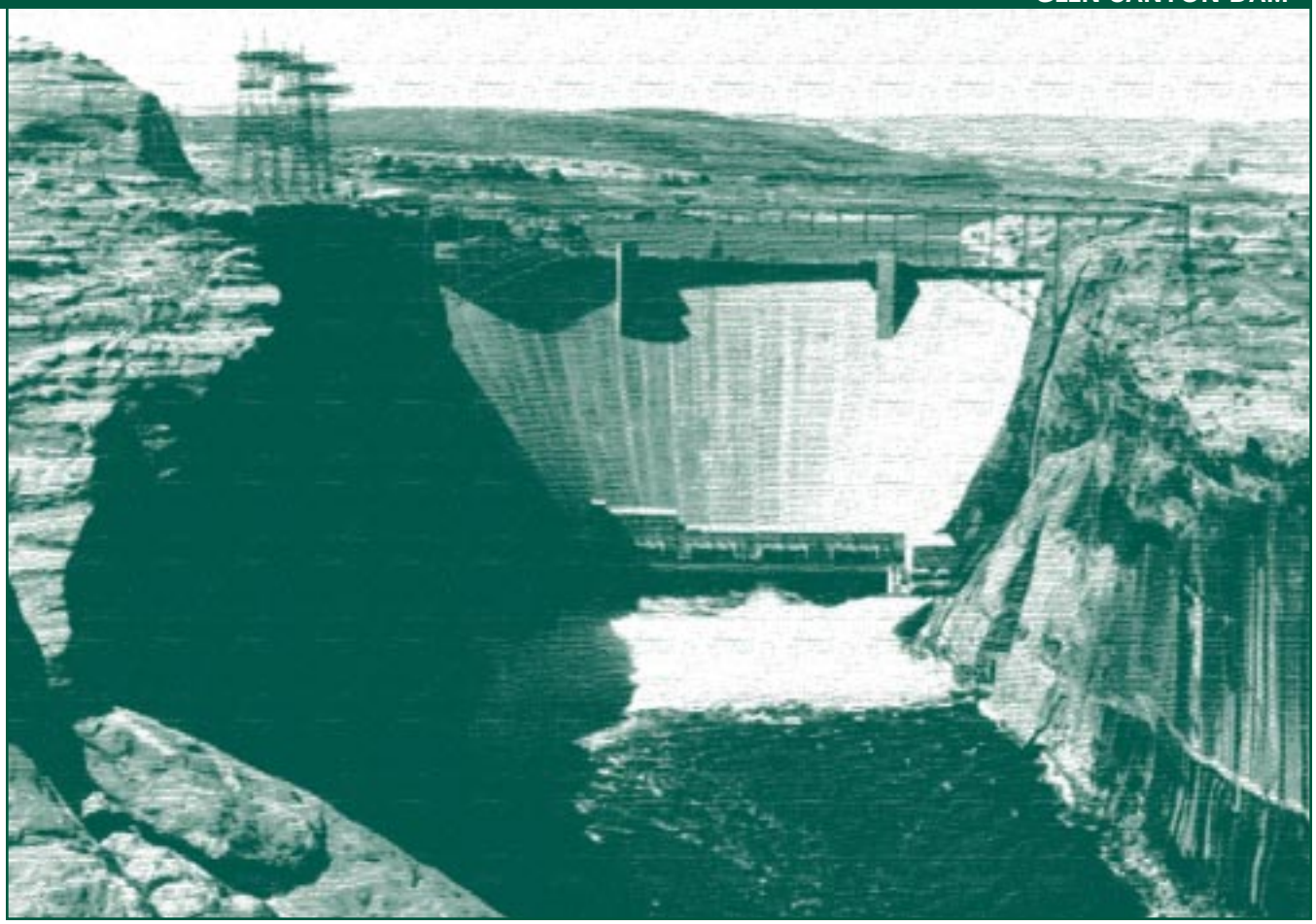
FONTNELE DAM

The FERC continues to be the leader in the field of EAP development, testing, guidelines preparation, and training. The agency is aggressively pursuing higher level EAP exercises to incorporate local and state disaster preparedness agencies and will begin working with FEMA's Project Impact communities. Other agencies with strong EAP programs include the Corps of Engineers, the BOR, TVA, and the U.S. Fish and Wildlife Service (USFWS). FEMA and its partners in the National Dam Safety Program are aware that some agencies could improve their EAP programs, and are undertaking a number of initiatives to improve performance.

On March 22, 1996, the Commissioner of Reclamation initiated an independent review of the Department's Dam Safety Program. This review was accomplished under contract with ASDSO. A Dam Safety Peer Review Team, consisting of six independent dam safety experts from outside of the Department, performed the review of the dam safety programs of the Department of the Interior agencies involved in dam safety. The Team used the ASDSO formal peer review process, *Peer Review for Dam Safety Agencies*, the *Guidelines*, and the Department Manual, Part 753, as guidance for its review. In FY 1997, each bureau received an individual report from the Team that listed findings and made recommendations for dam safety program improvements to the individual bureau. Each bureau has taken steps to address the findings or the recommendations in their individual bureau dam safety peer review report.

Of note, the BOR reported that they received 45 findings which were considered actionable in the Peer Review Report from the Team. To emphasize the importance of the program, the BOR established a Government Performance and Results Act (GPRA) goal to have all of the actionable findings addressed by the end of FY 1999. This has been accomplished. The BOR has a Web site (**www.usbr.gov/recman/fac/index.htm**) that includes current policies and directives designed to enhance communication within the BOR, and to provide current information to the public. The BOR Chief, Dam Safety

GLEN CANYON DAM



Office, provided ICODS with a presentation and report on the BOR Peer Review in FY 1998.

The reporting of dam incidents to the NPDP will greatly facilitate the work of decision-makers in dam safety. Of the agencies reporting, almost all are aware of the need to report incidents to the NPDP and about one-half state that they are doing so. The remainder indicate that they will do so in the future.

Implementation of Guidelines by Agency

Below is a description of federal agency activities during FY 1998-1999 in some of the areas covered by the *Guidelines*.

Organization, Administration, and Staffing

As in previous reporting periods, reductions in funds and the corresponding decrease in staffing levels for dam safety remain a concern. For example, dam engineering expertise and staffing levels at the NRCS have declined in most parts of the country in recent years as the federal dam design and construction workload has decreased. NRCS installed more than 1,200 NID-size dams in 1965 but less than 30 in FY 1998. The total number of engineers and engineering technicians in NRCS has declined by more than 20 percent over the past 5 years, and current staff is not sufficient to provide highly qualified technical assistance for dams in every state. Although the majority of NRCS states report that they have an adequate organization and staff for dealing with routine dam safety responsibilities and current workload, technical specialists in several disciplines, particularly soil mechanics, are not readily available in NRCS to provide timely expert assistance on large dams. To assist with staffing, the NRCS has signed a Memorandum of Understanding with the BOR to collaborate and share technology and resources on water resource activities.

The Corps of Engineers reports that there are serious challenges facing its dam safety organization and the dam safety community in the United States. There is a limited number of large dams under construction in the United States. The Corps of Engineers is not immune to this trend. Further, the agency is facing decreasing budgets and private sector contracting guidelines, which decrease the amount of work available to maintain a highly skilled technical workforce. Most of the technical personnel involved in the dam design and construction surge of the 1960's and 1970's have retired. To deal with these expertise challenges, the Corps of Engineers has a variety of initiatives to maintain a viable and well-qualified workforce, including on-the-job training during construction projects, an extensive training program, active participation on ICODS, and an extensive research and development program.

Dam Safety Training Activities

Training continues to be a strong aspect of most of the federal programs in dams safety. The NRCS and the ARS have developed a training course for the SITES software and technology. A short version of the course was offered at the FY 1998 ASDSO conference. NRCS engineers also actively participate in training conducted by others, such as ASDSO and ICODS, although this participation has decreased significantly over the past few years because of reductions in staffing levels. The NRCS reports that many NRCS states use the TADS modules and cooperate with their state dam safety agencies in conducting joint training seminars and workshops.

The main thrust of TVA's training continues to be on-the-job training under the supervision of experienced engineers and inspectors. TVA has a training program (including both classroom and hands-on instruction) for operating, maintenance, and inspection personnel. A wide range of outside training opportunities also is provided, including conferences, seminars, committees, and short courses.

The FERC designs its own training courses to directly fulfill the agency's dam safety training needs. In FY 1998, a course on civil engineering case histories was developed. Headquarters staff also traveled to each of the agency's Regional Offices to conduct training in the use of finite element analysis methods to analyze structural behavior of dams. In FY 1999, FERC established a priority on managerial, collaborative, and communication training in support of the FERC First implementation. The agency plans to continue courses on EAP testing that will allow its program to remain consistent with modern technology. FERC personnel also use the TADS modules.

The Corps of Engineers has an extensive program for training personnel in all matters related to its mission in water resources development. The program consists of conferences, seminars, formal classroom training, and periodic on-site training. Training courses sponsored by the Corps of Engineers during this reporting period included design and safety surveillance of embankment dams, seismic stability of embankment dams, probability and reliability in civil engineering, and probability and reliability in geotechnical engineering. Practical on-the-job training is continually provided using formal exercises simulating dam safety emergencies. Alert notification tests, which are conducted at the project level, involve various levels of the Corps of Engineers organization as well as other federal, state, and local officials. The agency also uses the TADS modules extensively to train project personnel and in its public awareness program for local officials.

The BOR actively participates with organizations and professional societies to provide training opportunities and facilitate information and technology exchange. Training programs included the annual Department of the Interior Dam Safety Coordinators Meeting, 1-week seminars on the Safety Evaluation of Existing Dams (SEED), a 2-week International Technical Seminar and Study Tour, and two 1-week Water Management Workshops. The BOR personnel also administered the TADS program and sponsored the Dam Safety Training Program at Southern University in Baton Rouge, Louisiana.

In both FY 1998 and 1999, the Mine Safety and Health Administration (MSHA) conducted 1-week training courses for its impoundment specialists. During these seminars, MSHA engineers and invited speakers reviewed information on dam design and inspection and provid-

ed updates on new dam safety developments and products.

Emergency Action Planning

NRCS reports that it has limited authority to require the development of EAP's. Most recent NRCS data shows that 316 of 1,572 high-hazard potential NRCS-assisted dams have current EAP's. NRCS state offices report varying situations. Minnesota, Missouri, Nebraska, and Wisconsin report that all NRCS-assisted high-hazard potential dams have EAP's. NRCS in Georgia reports that no NRCS-assisted dam currently has an EAP.

The United States Forest Service (USFS) reports that all USFS-owned dams that require an EAP have one, but approximately 50 permitted high-hazard potential dams lack EAP's. Some EAP's are in need of update, and few are tested on a routine basis.

The Department of Energy reports that EAP's have been prepared and approved for all high- and significant-hazard potential dams. All plans have been tested and retesting is planned every 3 years.

The U.S. Section of the International Boundary and Water Commission (IBWC) has an EAP in place for each of its two large high-hazard potential dams. Extensive flood emergency workshops continue to be held each year at Amistad, Falcon, and in the Lower Rio Grande Valley with representatives from the Mexican Section, IBWC, National Weather Service (NWS), River Forecast Center, and Texas Water Master.

All 19 dams under the purview of the Nuclear Regulatory Commission (NRC) are low-hazard potential, and it is unlikely that the hazard status of any of these dams will be elevated. For that reason, NRC does not have an emergency action planning program for dam safety. However, arrangements have been made with FERC for technical assistance with EAP's should the need arise.

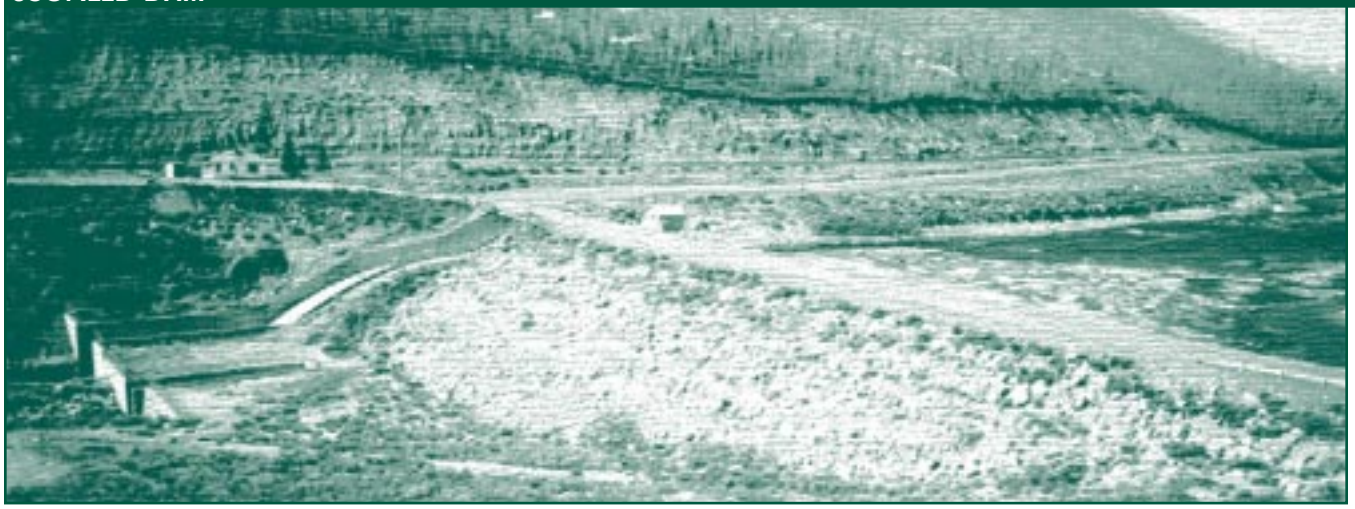
EAP's have been developed and maintained for all TVA dams. Exercise program activities completed during this reporting period included communications equipment testing; automated notification drills for individual TVA organizations, both during and after hours; and a functional level exercise at Fort Patrick Henry Dam. Emergency preparedness classroom training sessions (24) for TVA project, security, and field personnel also were conducted.

The FERC continues to be the lead agency in EAP development, testing, guidelines preparation, and training for the federal and regulated dams industry. FERC provides training for federal agencies and has been a major participant in the revision of ICODS EAP Guidelines. FERC has provided significant assistance to FEMA in its effort to develop training for private small dam owners on the development and testing of EAP's.

In November 1998, FERC issued revised EAP guidelines to promote national consistency with the newly-issued Federal Guidelines for Dam Safety: Emergency Action Planning for Dam Owners. (Existing FERC EAP guidelines were used as the basis for the revisions to the federal guidelines.) All licensees and exemptees are required to revise their EAP documents by December 31, 1999, to follow the established federal and FERC format. Because FERC considers in-depth testing of an EAP essential for all participants, the agency is requiring licensees to conduct functional exercises (comprehensive exercises without field mobilizations) to involve the emergency preparedness agencies in EAP testing. FERC held three EAP training courses in both FY 1998 and 1999.

The agency continues to aggressively pursue the higher level EAP exercise (tabletop and functional) to incorporate local and state disaster preparedness agencies. Under the FERC EAP exercise program, each licensee and exemptee with a high-hazard potential dam conducts a tabletop and functional exercise of an EAP on at least one of its dams during a 5-year period. Recently, FERC has made special efforts to increase the cooperation and coordination between dam owners and the local response agencies associated with the EAP's. As a result, representatives from state dam safety offices, local and state emergency response agencies, flood plain managers, the National Emergency Management Agency (NEMA), FEMA, and the NWS have been invited to FERC's EAP training courses. The exchange of information among these agencies and licensees has resulted in an improved understanding of the needs of each participant. For example, local

SCOFIELD DAM



road names can be added to maps, evacuation routes normally used can be highlighted so alternate routes can be chosen, and the range of possible flooding can be addressed. These efforts will greatly improve the likelihood of saving lives should an emergency occur.

FERC also initiated an effort to encourage licensees to develop EAP exercises that include active participation by upstream and downstream dam owners. Both FERC regulated dams and non-FERC regulated dams would be included. This widened approach for coordination will optimize the time and effort required by the local response agencies, and will encourage many non-FERC regulated dam owners to participate in an EAP exercise for the first time. This effort also includes coordination with NEMA, the Association of State Floodplain Managers, FEMA, the NWS, and state emergency management agencies. To further the cooperative spirit, FERC is encouraging all dam owners to coordinate with and include the NWS in their EAP's. By working together, dam owners and the NWS can exchange valuable information during flood events for use in flood forecasting models. Actual data will improve the forecasting ability of the NWS in developing warnings to communities. Dam owners will benefit from this partnership by using the capabilities of the NWS to broadcast flood warnings downstream of their dams.

The Army conducted workshops on EAP's and sent copies of the ICODS Technical Guidance on EAP's to each installation owning dams. Local government involvement is being encouraged during the formulation of EAP's and during major construction or repair project review.

EAP's have been completed for all but 1 of the 460 Corps of Engineers projects requiring an EAP, and the remaining EAP is under development for the Mt. Morris Dam in New York. All dams were reviewed for the possible need for EAP's, and it was determined that 109 dams do not require them because spillway discharges, flooding upstream, or failure do not have the potential for loss of life downstream of the project. During this reporting period, EAP's were tested by conducting dam safety emergency exercises at several Corp of Engineers dams. The Corps of Engineers notes that while it has initiated or completed all of the dam safety EAP's, the local communities responsible for the evacuation plans have not. To date, the agency is aware of approximately 70 projects where local evacuation plans have not been completed by the local entities. The Corps of Engineers districts continue to encourage local entities to develop their portion of the dam safety plans. Districts are being asked to increase their public awareness programs and perform follow-up visits to local communities to obtain the status of evacuation plans.

The USFWS reports that all of its high- and significant-hazard potential dams have EAP's and are updated annually.

The BOR reports that it has developed an EAP for each of its dams that provides specific pro-

cedures for notifying local emergency management personnel of anticipated high water releases or dam failures in response to specific initiating conditions. BOR's directives require that EAP's be updated annually and that they be exercised every 3 years. The major efforts at the BOR have been to include specific initiating conditions into the EAP and to incorporate levels of alert. In FY 1999, BOR established a Government Performance and Results Act (GPRA) goal to complete initial EAP exercises and update all EAP's for high- and significant-hazard potential dams. During the reporting period, EAP's were activated on three dams because of incidents that occurred at the dams.

Research and Development and Special Initiatives

The NRCS and the ARS are continuing a major, long-term research and development effort to model erosion processes in earth spillways during flood flows and on embankment dams during overtopping flows. The two agencies have monitored earth spillway performance during flood flows since 1983, and continue to build a database on performance based on spillway geometry, flood flow, and soil/rock parameters. Engineers and geologists from the NRCS and ARS have published over 50 papers in professional journals on their findings. This work has culminated in a mathematical model to predict initial failure of the spillway vegetation, initial gully formation, and progressive advancement of the headcut through the spillway. The model has been documented in several NRCS technical handbooks and incorporated into the SITES software. NRCS and ARS are continuing to enhance the SITES software by adding technical features and a user-friendly interface. The current version of SITES can be used to develop inflow hydrographs, compute spillway system hydraulics, calculate peak reservoir elevations, and determine ultimate spillway headcut advance for a single dam site. The future version of SITES will provide information for multiple dam sites in a series. The NRCS/ARS team has developed a modularized training course that explains the technology and the software, and has been training NRCS engineers over the past year.

Since the last reporting period, TVA completed an inventory and assessment of the condition of all dam safety instrumentation. TVA is recognized as an expert in dealing with concrete growth caused by Alkali Aggregate Reaction. TVA serves as a consultant to the Corps of Engineers, Tapoca, and other utilities, both nationally and internationally, on concrete growth. The agency has developed a state-of-the-art monitoring system (Smart Dam) to study the effects of remedial efforts at three projects with concrete growth. At the request of the Panama Canal Commission, TVA performed an inspection and non-destructive testing of the steel penstocks at four units at the Gatun Hydro Facility. TVA also is conducting planning and operational studies for the Ankang-Danjiangkou section of the Hanjiang River in China.

As a regulatory agency, the FERC is limited in the extent of actual research and development. The agency is very active, however, in participating, funding, and co-funding important dam safety research that will benefit the owners of non-federal hydropower projects. FERC staff participates in the Interagency Research Coordination Conference and provides technical expertise to numerous research task forces and committees. In FY 1998 and 1999, FERC participated and provided technical guidance to the BOR's Erosion Characteristics of Dam Foundations research effort that is on-going at Colorado State University. Special initiatives in the FERC dam safety program during this reporting period include the in-depth inspection and analysis of tainter gates, the continuing effort to better define the seismic hazard risk to dams, and the electronic filing of dam safety inspection reports.

The Navy Facilities Engineering Service Center has conducted a research and development program on evaluation of seepage flow through drydock and waterfront structures. The results of the research program may be applied to dam stability analysis in the future.

Many of the Corps of Engineers research projects are directly or indirectly related to dam safety, including two focused research programs: the Risk Analysis for Dam Safety Research Program and the Earthquake Engineering Research Program. The objective of the Risk Analysis for Dam Safety research program is to develop and implement risk analysis methods to prioritize

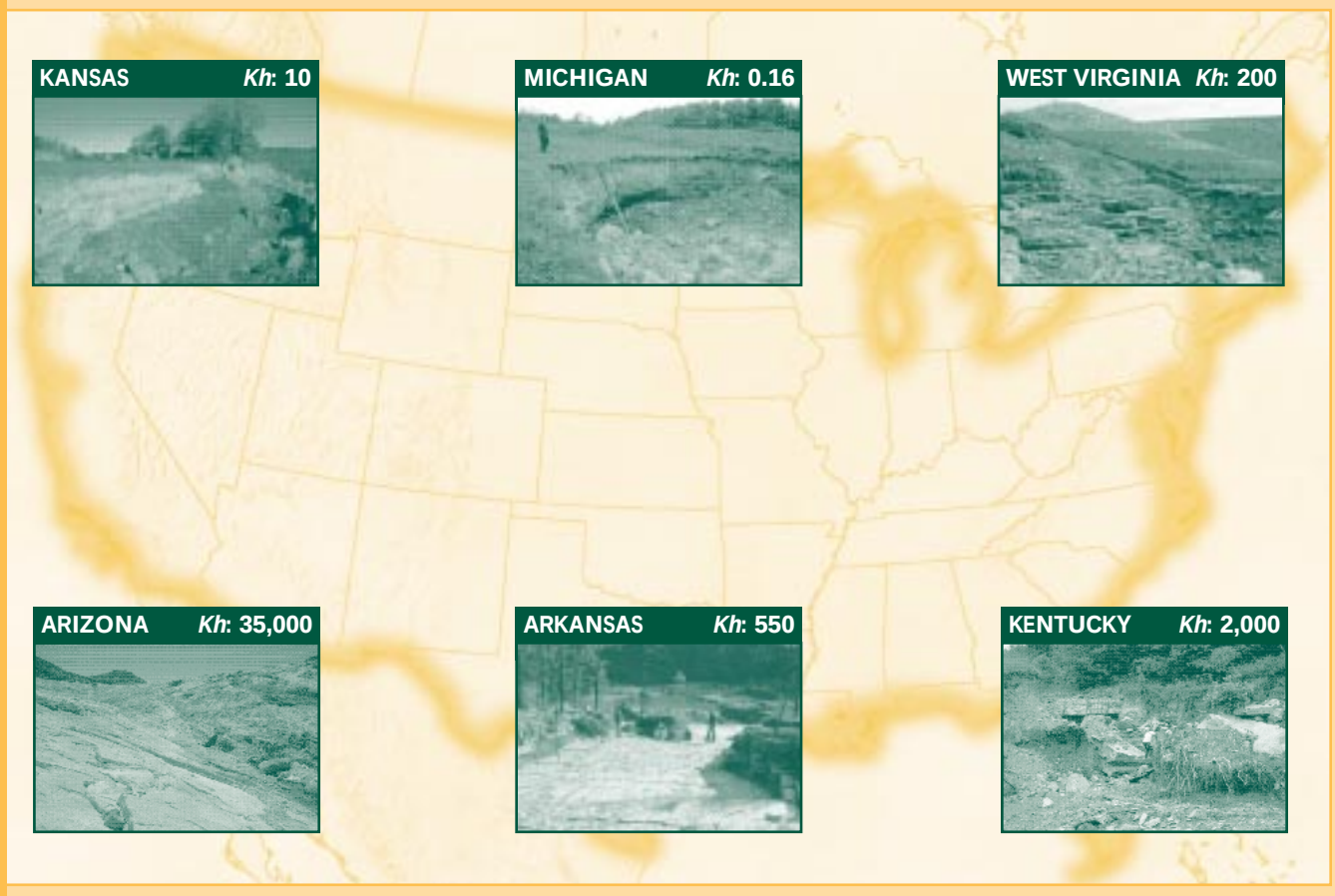
dams requiring initial investigations and subsequent analyses; prioritize funding for critical repairs, rehabilitation, or modifications; select and justify the optimal plan to protect human life, reduce property damage, and mitigate environmental damage; minimize the disruption of services; and maximize effectiveness of infrastructure investments. The objective of the Earthquake Engineering Research Program is to reduce damage from a potentially devastating earthquake by advancing state-of-the-art knowledge of earthquake hazard assessment, seismic design, and remediation of Corps of Engineers dams and other infrastructure. The agency has a very active technology transfer program for both of these research initiatives.

The Corps of Engineers also has taken the lead in coordinating the development of the Dam Safety Program Performance Measures (DSPPM) program for use by federal and non-federal agencies. At the direction of ICODS and the National Dam Safety Review Board, the Corps of Engineers will develop software that will interact with the NID. Each user will eventually have a stand-alone computer program database that will serve as a self-evaluation tool and allow both internal and external reporting on dam safety program status, degree of implementation, and improvement.

The USFWS is increasing its emphasis on the use of incremental damage assessments and risk assessments in the rehabilitation of existing dams. One project included a value engineering study performed by the BOR that emphasized risk-based decision-making.

Headcut Erodibility Index

The headcut erodibility index, Kh, is used in calculating the upstream advance of a headcut in an earth auxiliary spillway. The index is determined quantitatively through laboratory soil strength tests and field determination of rock material and mass properties. The following photos represent examples of various materials for which index values have been determined. These may provide guidance in identifying common ranges in index values for similar materials.



Source: USDA, Hydraulic Engineering Research Unit, Stillwater, Oklahoma

The BOR continues the use of risk analysis in its evaluation process. Collaboration with the Canadian Electric Association and Australian interests is continuing. Communication and collaboration also is occurring with the Corps of Engineers. The BOR has produced a guideline "Dam Safety Risk Analysis Methodology" which is a working guideline on risk analysis methods and a series of technical guides which define procedures for estimating risk.

The topics of collaborative research projects sponsored by the BOR include pre- and post-failure deformations of slopes; radial gates research; sliding resistance of concrete gravity dams; seepage and piping associated with embankment dams; internal diagnostics of embankment dams; pipe box research; hydrologic and paleo-flood studies; breach characteristics of embankment dams; dam foundation erosion; and dam overtopping. The BOR publishes reports on its research at www.usbr.gov/dsis/research/reports.html.

YELLOWTAIL DAM

State Accomplishments

The State Assistance Program under Public Law 104-303

The state assistance program is intended to help states bring the necessary resources to bear on inspection, classification, and emergency planning for dam safety. Public Law 104-303 provides for the two-tiered assistance program described below.

For a state to be eligible for primary assistance under the National Dam Safety Program, the state dam safety program must be working toward meeting the following criteria, as listed in Public Law 104-303:

- The authority to review and approve plans and specifications to construct, enlarge, modify, remove, and abandon dams;
- The authority to perform periodic inspections during dam construction to ensure compliance with approved plans and specifications;
- A requirement that state approval be given on completion of dam construction and before operation of the dam;
- The authority to require or perform the inspection at least once every 5 years of all dams and reservoirs that would pose a significant threat to human life and property in case of failure to determine the continued safety of the dams and reservoirs, and a procedure for more detailed and frequent safety inspections;

TABLE 3: STATE GRANT AMOUNTS FOR FY 1998-1999

STATE	FY 1998	FY 1999	TOTAL
Alabama	0	0	0
Alaska	8,100	16,042	24,142
Arizona	9,616	18,921	28,537
Arkansas	11,703	23,009	34,712
California	20,651	40,198	60,849
Colorado	25,162	49,230	74,392
Connecticut	14,910	29,205	44,115
Delaware	0	16,000	16,000
Florida	13,475	26,430	39,905
Georgia	50,819	84,315	135,134
Hawaii	8,657	17,106	25,763
Idaho	10,964	21,904	32,868
Illinois	20,096	39,655	59,751
Indiana	19,780	0	19,780
Iowa	0	0	0
Kansas	75,139	129,664	204,803
Kentucky	18,161	35,755	53,916
Louisiana	10,616	20,944	31,560
Maine	13,323	28,767	42,090
Maryland	10,453	20,360	30,813
Massachusetts	23,727	46,101	69,828
Michigan	17,074	32,438	49,512
Minnesota	15,889	34,128	50,017
Mississippi	44,035	84,483	128,518
Missouri	13,921	27,307	41,228
Montana	38,393	69,150	107,543
Nebraska	29,315	57,094	86,409
Nevada	12,073	25,874	37,947
New Hampshire	13,965	27,828	41,793
New Jersey	15,954	31,186	47,140
New Mexico	11,823	23,969	35,792
New York	28,598	103,039	131,637
North Carolina	29,304	57,532	86,836
North Dakota	12,519	28,683	41,202
Ohio	26,554	51,524	78,078
Oklahoma	54,896	105,634	160,530
Oregon	16,150	31,937	48,087
Pennsylvania	20,705	40,344	61,049
Puerto Rico	7,700	15,222	22,922
South Carolina	31,609	61,015	92,624
South Dakota	0	61,808	61,808
Tennessee	13,530	26,827	40,357
Texas	80,703	155,717	236,420
Utah	14,062	26,472	40,534
Vermont	10,921	21,695	32,616
Virginia	12,486	32,104	44,590
Washington	12,193	23,969	36,162
West Virginia	10,736	20,944	31,680
Wisconsin	17,802	34,628	52,430
Wyoming	21,738	38,863	60,601

TABLE 4: SUMMARY STATUS OF DAMS BY STATE

STATE	NATIONAL INVENTORY				STATE REGULATED			
	Total	Hazard Classification			Total	Hazard Classification		
		High	Sig.	Low		High	Sig.	Low
Alabama[B]								
Alaska	115	23	33	59	87	15	27	45
Arizona	322	106	77	139	212	72	55	85
Arkansas	1,229	167	214	848	396	99	91	206
California					1,253	394	715	144
Colorado	1,540	245	308	987	1,574	245	308	1,021
Connecticut	706	226	452	28	706	226	452	28
Delaware[B]								
Florida	573	72	126	375	573	72	126	375
Georgia	4,676	376	n/a	4,300	3,701	376	n/a	3,325
Hawaii	129	56	15	58	129	56	15	58
Idaho	353	92	125	136	426	95	139	192
Illinois	1,202	162	271	769	1,258	162	271	825
Indiana[B]								
Iowa[D]	3,069	75	171	2,823	3,054	69	169	2,816
Kansas	5,568	165	333	5,070	6,278	171	324	5,783
Kentucky	1,058	201	206	651	1,020	287	238	495
Louisiana	310	11	46	253	310	11	46	253
Maine	749	64	197	488	635	22	152	461
Maryland	285	58	75	152	380	58	75	247
Massachusetts	1,567	333	766	468	1,567	333	766	468
Michigan	877	140	192	545	672	78	154	440
Minnesota	942	40	152	750	846	29	140	677
Mississippi					3,418	257	66	3,095
Missouri	4,075	602	912	2,561	620	436	127	57
Montana	2,616	97	122	2,397	2,864	97	127	2,640
Nebraska	2,044	93	241	1,710	2,044	93	241	1,710
Nevada	412	104	111	197	401	99	108	194
New Hampshire	640	86	207	347	813	87	197	529
New Jersey	811	186	369	256	1,613	186	412	1,015
New Mexico	531	169	74	288	455	137	66	252
New York	1,949	379	783	787	1,949	379	783	787
North Carolina	2,064	814	362	888	4,305	803	706	2,796
North Dakota	737	28	97	612	562	20	69	473
Ohio	1,767	502	540	725	1,730	467	540	723
Oklahoma	4,513	183	92	4,238	4,486	167	91	4,228
Oregon	819	122	181	516	1,177	122	181	874
Pennsylvania	1,411	811	209	391	1,239	737	196	306
Puerto Rico	35	34		1	35	34		1
Rhode Island[D]	510	16	41	453	510	16	41	453
South Carolina	2,243	148	458	1,637	2,243	148	458	1,637
South Dakota	2,409	84	155	2,170	2,269	51	144	2,074
Tennessee	993	213	309	471	582	140	197	245
Texas	6,761	820	760	5,181	6,761	820	760	5,181
Utah	634	195	216	223	530	173	208	149
Vermont	338	47	132	159	338	47	132	159
Virginia	1,520	145	262	1,113	488	104	119	265
Washington	666	191	171	304	527	107	144	276
West Virginia	465	289	112	64	310	238	61	11
Wisconsin	1,081	202	200	679	966	146	172	648
Wyoming	1,359	76	102	1,181	1,359	76	102	1,181

DAM INSPECTIONS[A]				DAMS WITH EAP'S[A]	
Total	Hazard Classification			High	Sig.
	High	Sig.	Low		
17	3	9	5	4	2
46	24	13	9	51	16
313	86	72	155	52	
964	394	542	28	115[C]	
665	246	176	243	245	283
42	35	6	1	160	126
501		126	375		
697	386	n/a	311	5	n/a
10	10			5	
				76	25
124	62	29	33	112	93
1	1				
105	60	40	5	17	
439	186	115	138	3	
88	8	34	46	2	1
58	11	21	26	9	
132	52	29	51	31	21
439	191	212	36	30	
224	20	33	171	53	68
102	29	28	45	29	
135	113	2	20	22	
128	83	30	15	20	10
10	10			97	
544	49	82	413	90	6
167	93	33	41	13	
156	33	43	80	73	112
98	73	13	12	124	87
120	60	22	38		
589	207	188	194	127	32
1,856	1,053	260	543	84	12
169	8	26	135		
103	42	33	28	48	46
443	167	8	268	137	6
345	122	60	163	57	10
1,138	645	102	391	61	25
12	12			1	
14	14				
281	148	133		133	410
64	15	12	37	68	
333	127	98	108	140	
91	33	42	16	7	
328	178	101	49	171	
42	11	8	23	15	15
302	73	74	155	104	119
40	19	6	15	71	20
100[C]				170	2
33	7	8	18	33	10
279	21	11	247	27	3

A State-regulated dams.
B Not participating in NDSP grant program.
C Total; not separated by hazard.
D Not participating in NDSP grant program but submitted data.

- A requirement that all inspections be performed under the supervision of a state-registered professional engineer with experience in dam design and construction;

- The authority to issue notices, when appropriate, to require owners of dams to perform necessary maintenance or remedial work, revise operating procedures, or take other actions, including breaching dams when necessary;

- Regulations for carrying out the legislation of the state;

- The provision for funds to ensure timely repairs or other changes to or removal of a dam to protect human life and property, and if the owner of the dam does not take the action described above, to take appropriate action as expeditiously as possible;

- A system of emergency procedures to be used if a dam fails or if the failure of a dam is imminent; and

- An identification of each dam whose failure could be reasonably expected to endanger human life, the maximum area that could be flooded if the dam failed, and public facilities that would be affected by the flooding.

For a state to qualify for primary assistance, state appropriations must be budgeted to carry out the legislation of the state.

For FY 1998 and FY 1999, FEMA has allocated all state assistance funds under the primary assistance criteria of Public Law 104-303. Table 3 lists the state assistance grant amounts for FY 1998-1999.

FY 1999 is the first year for which the states have provided FEMA with data on the number of dams in their states by hazard classification; the number of dam inspections conducted each year; remediation needs; and the status of dams with EAP's by hazard classification. (See Table 4.) Table 5 compares by state the percent of EAP's by state-regulated high- and significant-hazard potential dams. This data will serve as the baseline for assessment purposes of state progress in the next biennial report. It also should be noted that in the case of some states, federal funding represents a small percentage of the state's overall funding for dam safety.

The following are samples of state accomplishments with National Dam Safety Program funds in FY 1998 and 1999.

TABLE 5: PERCENT OF EAP'S BY STATE-REGULATED HIGH- AND SIGNIFICANT-HAZARD POTENTIAL DAMS*

STATE	PERCENT	STATE	PERCENT
Virginia	100	Wisconsin	14
Colorado	95	Alaska	14
South Carolina	90	New York	14
New Hampshire	65	California	10
West Virginia	58	Ohio	9
Oklahoma	55	Pennsylvania	9
Arizona	53	Hawaii	7
Michigan	52	Mississippi	7
Illinois	47	North Carolina	6
Utah	45	Nevada	6
Idaho	43	Maine	5
Montana	43	Louisiana	5
Connecticut	42	Missouri	5
Tennessee	42	Massachusetts	3
Maryland	39	Kansas	3
Washington	36	Puerto Rico	3
New Jersey	35	Georgia	1
South Dakota	35	Kentucky	.05
Nebraska	29	Texas	.04
Arkansas	27	Florida	0
Oregon	22	Iowa	0
Vermont	17	New Mexico	0
Wyoming	17	Rhode Island	0
Minnesota	17	North Dakota	0

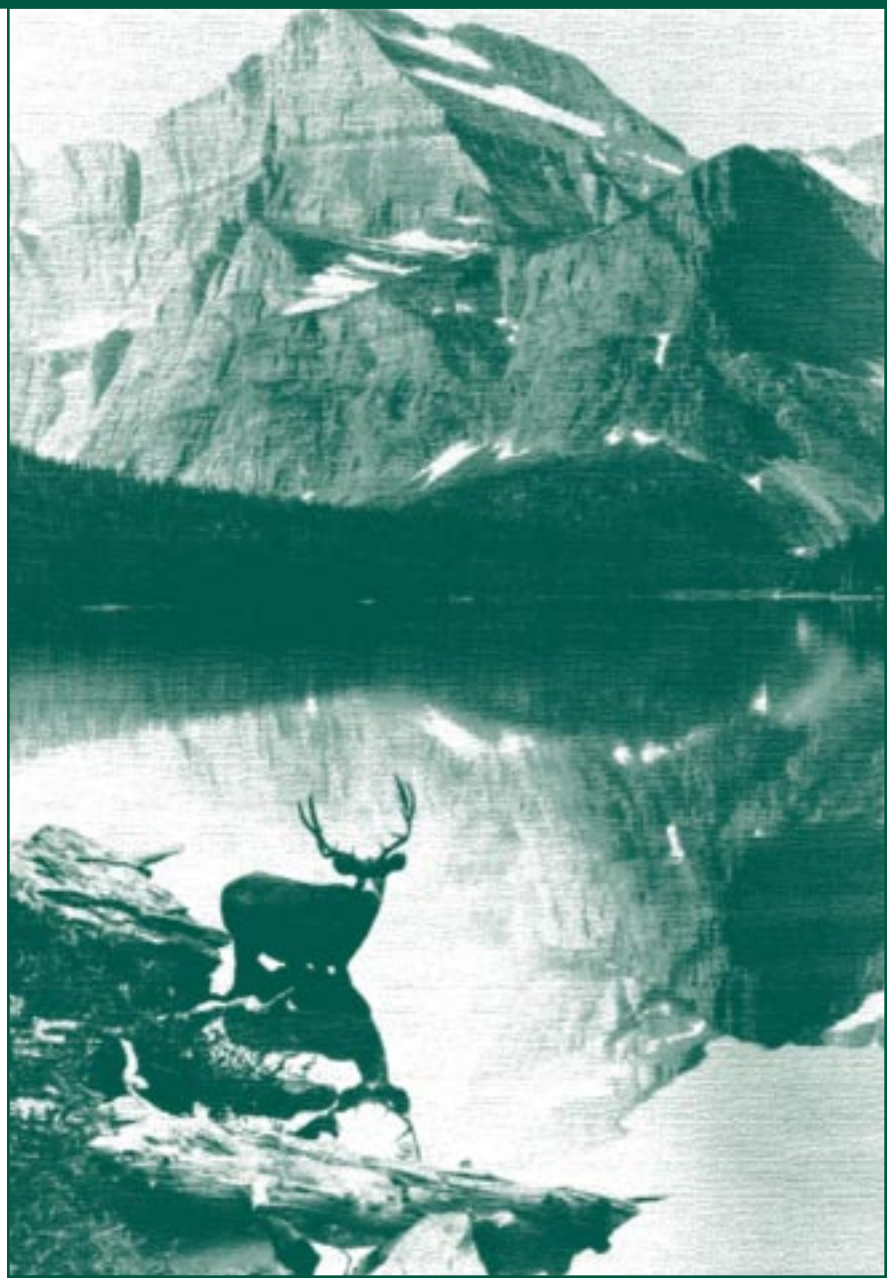
* Alabama, Delaware, and Indiana did not submit data.

STATE ACCOMPLISHMENTS IN FY 1998-1999

- Dam safety-related training for state personnel and training in the field for dam owners to conduct annual maintenance reviews
- Purchase of equipment, including state-of-the-art computer systems and software; new equipment to aid in engineering analysis; video inspection cameras to inspect conduits through dams; laptop computers for use in the field to complete inspection reports and other correspondence; surveying equipment; a four-wheel drive vehicle on which to mount a survey unit; and a TV-VCR to review conduit inspection videos
- Revision of state maintenance and operation guidelines
- Increase in the number of dam inspections
- Increase in the submittal of EAP's
- Increase in the turnaround time on the review and issuance of permits
- Improved coordination with state emergency preparedness officials
- The testing of EAP procedures through actual simulations of dam failures
- Construction of a maintenance baseyard
- Use of helicopters to reach some remote dams for inspections, and to reduce travel time to other dams for inspections
- Improvements to dam inventory databases
- Improved telecommunications
- Joint project with FEMA's Project Impact to develop EAP's
- Identification of dams to be repaired or removed
- Conduct of dam safety awareness workshops for dam owners on preparing EAP's
- Development of a proposed set of modifications to strengthen dam safety rules
- Creation of dam safety videos and outreach materials
- Development of a public relations plan and a dam safety newsletter

Focus on the Future

Although there has been great progress in dam safety over the last 20 years, much remains to be accomplished. The Nation's infrastructure of dams is aging. Over the next 20 years, the NPDP estimates that 85 percent of dams in the United States will turn 50 years old, suggesting the need for greater maintenance and/or major rehabilitation. Working with ASDSO and the ASCE, the NPDP looked at the overall cost of dam safety in the United States based on costs for the rehabilitation of dams with seismic, hydraulic, or operational concerns that make damage or failure a high probability; ongoing maintenance and repair of existing dams; the development and implementation of EAP's at all high- and significant-hazard potential dams; the maintenance of fully-staffed state and federal programs; and the yearly costs of dam failure. Based on those elements, the NPDP estimates that dam safety costs over the next 20 years could range from $750 million to $1.5 billion annually.



Other important issues relate to the identification and classification of dams, including the number of unregulated dams that have not been reported to the NID; the number of dams that have not been classified correctly; and whether the classification of a dam has changed. Moreover, hazard classification alone does not give a clear picture of the risk of failure; hazard classification is independent of the condition of the dam and represents only the potential consequence of failure relative to loss of life and property damage downstream.

Addressing these issues will be a priority of the national dam safety agenda in the next 2 years, as will sustaining the progress already made by all of the partners in dam safety. With the legislative authorization of Public Law 104-303 and the support and commitment of FEMA, the National Dam Safety Program will continue to provide the leadership and coordination needed to ensure the safety of all those who live, work, play, or receive benefits from dams.

LIST OF ACRONYMS

ARS	Agricultural Research Service
ASCE	American Society of Civil Engineers
ASDSO	Association of State Dam Safety Officials
BOR	Bureau of Reclamation
DSPPM	Dam Safety Program Performance Measures
EAP	Emergency Action Plan
EENet	Emergency Education Network
EMI	Emergency Management Institute
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FY	Fiscal Year
G-I	Geo-Institute
GPRA	Government Performance and Results Act
IBWC	International Boundary and Water Commission
ICODS	Interagency Committee on Dam Safety
ICOLD	International Committee on Large Dams
MSHA	Mine Safety and Health Administration
NEMA	National Emergency Management Agency
NFIP	National Flood Insurance Program
NID	National Inventory of Dams
NPDP	National Performance of Dams Program
NRC	Nuclear Regulatory Commission
NRCS	Natural Resources Conservation Service
NWS	National Weather Service
SEED	Safety Evaluation of Existing Dams
TADS	Training Aids for Dam Safety
TVA	Tennessee Valley Authority
USCOLD	United States Committee on Large Dams
USDA	United States Department of Agriculture
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service